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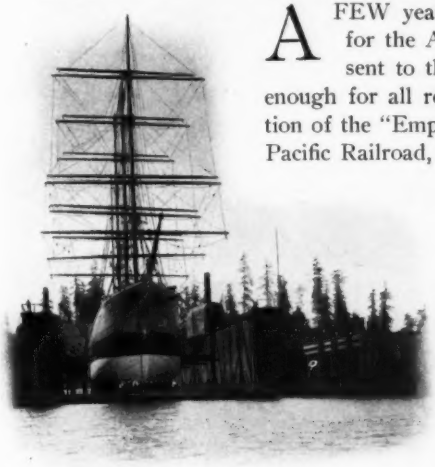
AMERICAN OVERLAND TRANSPORT TO THE ORIENT.

By Harrington Emerson.

Mr. Emerson does not treat his theme from the limited viewpoint of the rivalry of competing routes or ports, but from that of a current change in one of the great world tides of traffic. In this light it has universal interest and importance.—THE EDITORS.



A FEW years ago, steamers no longer fit for the Atlantic or Indian service were sent to the Pacific as being quite good enough for all requirements. With the exception of the "Empresses," built for the Canadian Pacific Railroad, there was not, until the Spanish-American war, a first-class steamer on the American Pacific. Now, the largest steamers ever constructed in American waters and with one exception, the Cedric, the largest steamers ever built, have been ordered for the Pacific Ocean traffic.

What has brought about the change? Why is it that San Francisco and Puget Sound, Honolulu, and even distant Nome, see in their roadsteads, not some, but many, of the largest ocean craft afloat? What is the cause and what is the future of this new movement? It has long been known that Western Asia is densely populated and that an enormous Asiatic trade exists, now going to Europe and America by

THE GOLDEN GATE. ENTRANCE TO THE HARBOR OF SAN FRANCISCO.

way of the Suez canal. It has long been known that Tokyo, Kobé, Shanghai, Hongkong, are nearer to San Francisco than to London and Hamburg; yet in spite of the development of Japanese import and export trade, in spite of the growth of trade relations with the Philippine Islands since their annexation to the United States, the greatest part of the carrying trade even from and to New York goes by way of Europe.

The reason is obvious. The Pacific Coast States are not as yet a manufacturing region. They are largely importers of eastern manufactured goods. Their own exports are raw materials, and with the exception of flour not such as the Orient demands.

Exports to the Orient must come from the eastern and southern States—railroad iron and other equipment, mining machinery, tobacco and cotton—and for these goods the usual railroad rate across the continent is prohibitive, as it costs almost twice as much to send boxed goods from New York to San Francisco as from New York to London, and thence by steamer direct to Puget Sound via the Suez canal, the Straits, Hongkong and Yokohama. The average railroad rate across the American continent in carload lots is $15 a ton; the rate on similar goods from London to Seattle is $10 a ton: and one of the chief ob-

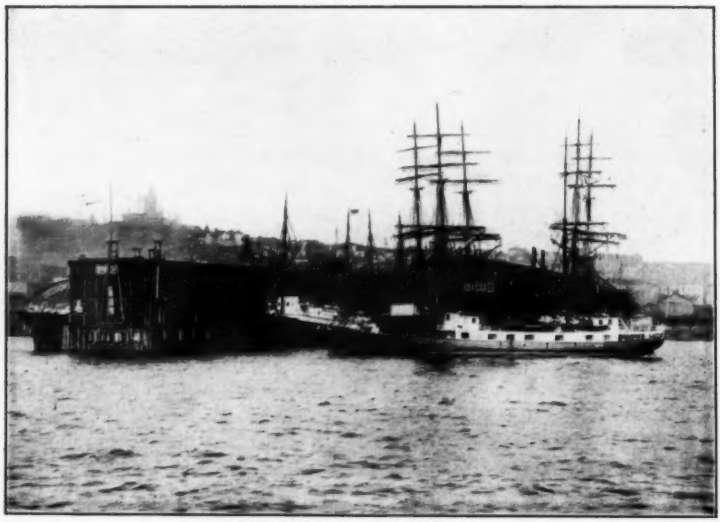
stacles to a lowering of the railroad rate through ocean competition is the requirement that American goods may not be shipped from an American port to an American port except in American bottoms. Before there could be any hope of a large increase in Pacific Coast exports and imports, the whole railroad situation had to be changed; and this is what has happened.

PANORAMA OF SAN FRANCISCO FROM TELEGRAPH HILL.

The settlement of the Pacific Coast dates from the discovery of gold in California. Between 1849 and 1873, the date of the completion of the first Pacific railroad, $1,200,000,000 in gold were taken from California mines and nearly $400,000,000 in gold and silver from the Nevada mines. There was no possibility of freight traffic between California and the rest of the United States except by sea, and as New York was as far away as London, as the war-inflated prices of the eastern States were still above those of Europe, California's imports of mining machinery and other manufactured supplies came largely from England. There was nothing for the ships to take back, until a very low rate was made on wheat exports when wheat raising in California began to assume importance, especially as wheat was worth over $1 a bushel. The early trade of California was distinctly of a maritime character, with steamer lines to Panama, to Hawaii, even to China and Japan, with many coasting lines, south to San Diego and north to Portland and Puget Sound. San Francisco was easily

the queen city of western America, and not only on account of the great wealth and equally great enterprise of the Californians, but because it was the only western city, it became the terminus of the first Pacific Railroad, built in an era when roads were constructed to enrich the promoters and not to make money out of operation. Of such a road the old Kansas Pacific was a good example. It was built through an unsettled country, receiving an enormous land grant; elementary dictates of common sense were neglected in its location, the road abounding in useless grades and cuts; and until reorganized, it never paid. The early Pacific roads were handicapped by unfortunate and often wholly unnecessary location over high mountain ranges, and this will forever add to their cost of operation compared to roads which have much lower grades or wholly escape mountain divisions, as will be the case with the Grand Trunk extension to the Pacific.

On the old Pacific Road, now so differently managed, there was one determining factor, namely, the competition from sailing vessels around Cape Horn. No attempt was made to develop local traffic. The hay rate from western Nebraska to western Wyoming was $900 a car, and emigrant passenger rates from Omaha to San Francisco as high as from New York to California by way of Panama. The emigrant coach was attached to a freight train running on a schedule of 11 miles an hour, and for twenty years after the opening of the rail-



COAL BUNKERS, SEATTLE.

THE TACOMA WATERFRONT.

road, the territory of Wyoming, equal in area to New York and Pennsylvania combined, and with great natural resources that the railroad should have developed, was able to give homes to no more than 60,000 people. Mr. Huntington imagined that by occupying the narrowest part of the United States between the Atlantic and Pacific he would always be able to control the trans-American traffic, little foreseeing that a constructive instead of monopolistic policy would be able to carry cotton from Texas to Puget Sound at a cheaper rate than his road could carry it from Galveston to San Diego. The era of monopoly ended with the construction of competing lines to the Pacific Coast, which have resulted not only in the substitution of American manufactures for British in California, but also in the development of the California fruit trade. The Pacific Mail, aided by a subsidy for the mails, maintained freight and passenger relations between Hawaii and the United States and relied for a large part of its income on the Chinese coolie trade, first to California and then to Hawaii; but it brought also silks, tea, and curios, thus making a beginning of a Pacific and Oriental traffic and trade.

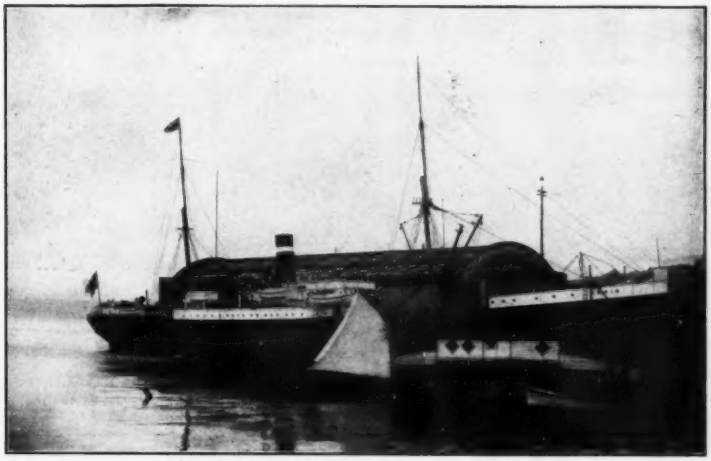
In the meantime the bonanza wheat farms of North Dakota had stimulated railroad building in that prairie region, and aided by the largest railroad land grant ever given, about 80,000 square miles, one of these roads pushed through to the Pacific, making its terminus at

THE DRYDOCK, PUGET SOUND NAVY YARD.

Tacoma, on Puget Sound, which is by far the best harbor on the Pacific Coast. This was still in the era of speculative railroad building, and it is not unfair to say that the Northern Pacific was built, not for the sake of any traffic immediately in sight, but to capture the land grant. The Canadian Pacific, from Montreal to Vancouver, paralleling the Northern Pacific at a distance of 300 miles and playing on the idea of international rivalry, was also built by grants and subsidies, and it became a competitor of the first importance, because, being subsidized and wholly beyond American control and largely beyond American pooling arrangements, with its terminal boat service it could and did

reach every American Pacific Coast city, and made strong bids for a share of the traffic.

There was, however, a stronger force yet to change the future, and one that distinctly inaugurated a new era. The Great Northern Railroad, a wheat road of Minnesota and North Dakota, had been developed and made by one man, Mr. James J. Hill, who, living on the line of his roads, from the very first built not for the sake of bonds or sub-



IN THE ALASKAN TRADE, SEATTLE.

sidies, but for the immediate and prospective traffic. Having made a great success of prairie roads, just when speculative building in American roads had ended, Mr. Hill began to reach out toward the Pacific and completed his through line in the darkest days of financial and industrial depression, but when steel and labor were at their lowest. The project was ridiculed by those whose standards belonged in the past. Mr. Hill neither asked for nor received a subsidy, but built his road as a simple business undertaking. It was built so well, and withal so cheaply, that he made the boast that he could pay all fixed charges at a freight rate which would not pay operating charges on the extravagantly constructed subsidized lines of the earlier period. He was the first to apprehend that the State of Washington had the most gigantic lumber resources in the world, that one acre of Washington timber will furnish in its lumber as many car loads of freight as 120 years of wheat product from a Dakota farm, and that this lumber, unique in its dimensions and cheapness, was needed not only among the prairie

GREAT NORTHERN DOCKS, SEATTLE. LOADING WHEAT FOR EUROPE AND COTTON FOR JAPAN.

GRAIN ELEVATORS AT TACOMA.

farmers but all over the United States. All other transcontinental railroads had been constructed with an eye to west-bound traffic. Mr. Hill's road was built for east-bound traffic. The wheat cars, filled to overflowing at the crop-moving seasons of the year and then standing idle on side tracks of Dakota, could be utilized all the year through to carry Washington lumber eastward.

PORT BLAKELY MILLS—THE LARGEST LUMBER MILLS IN THE WORLD.

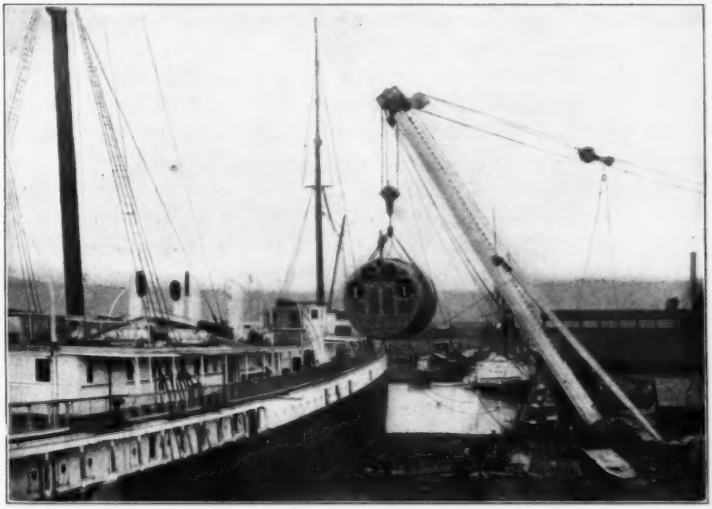
The terminus of his road was Seattle, also on Puget Sound, and also with great natural terminal facilities. The "Empress Line" from the terminus of the Canadian Pacific at Vancouver had become the fastest and best-patronized line across the Pacific. At Vancouver were unlimited supplies of good coal at very low price, and the route to Yokohama, Hongkong, and India is over a thousand miles shorter than the first established route via Hawaii. Seattle and Tacoma have at their back doors coal fields more extensive than those of Vancouver. These two cities are as near to the Orient as the Canadian Pacific terminus, so Mr. Hill, feeling sure that he could divert a part at least of the tea and silk trade to his own railroad line, early formed an alliance with the greatest of Japanese lines—the Nippon Yusen Kaisha, a line in ocean tonnage ranking among the foremost in the world, adding the factor of the very low cost of operation of steamers under Japanese control to the other advantages of cheap coal and short

route. This was at a competitive period when he regarded the other continental lines as rivals; and as an example of what could be done the Great Northern actually invaded the Southern California fruit regions, brought fresh fruit by steamer to Seattle, and sent it in the cool northern spring to Chicago, making shorter time than by the southern roads. Owing to the development of the Washington lumber industry, the traffic east-bound much exceeds the west-bound freight,

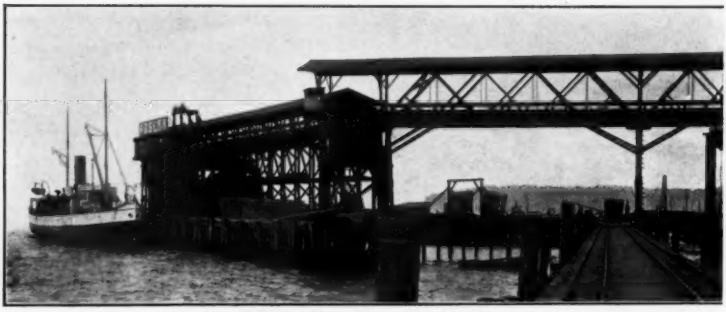
YELLOW PINES 225 FEET HIGH IN A CALIFORNIA FOREST.

so, on an actual count recently made, nearly five times as many loaded cars are moving east as going west. It became plain that as the northern roads, all of them, earned dividends in the prairie regions from their grain traffic and paid all the expenses of western operation by the east-bound lumber traffic (thus reversing the conditions that had prevailed for all the southern roads) it would be possible to carry

LAUNCH OF A SCHOONER AT MORAN'S SHIP-YARD.



HOISTING 60-TON BOILERS INTO THE S. S. CITY OF PUEBLA, SHIP-YARDS OF MORAN BROS. CO., SEATTLE.



ROSLYN COAL WHARVES, SEATTLE.

west-bound freight at nominal rates—any rate above the cost of handling and the slight increase in expense of hauling full cars instead of empties. With the establishment of the Nippon Yusen Kaisha line, which fortunately occurred when the price of wheat and flour was at its lowest, the Oriental trade began to assume large dimensions, the steamers going out with full Orient-bound cargoes, but bringing back comparatively little. It was during this same period that a great number of Japanese cotton mills were started, the cotton being imported from the United States by way of London and Hamburg. All the conditions were now favorable for a revolutionary move of world-wide importance. The Northern Pacific paralleled the Great Northern; both started at St. Paul and both reached Seattle; both had many branch lines in the grain fields of Dakota; both ran through the richest lumber forests of Washington. The Burlington, a corn road, reaching St. Louis, was an ally of the Northern Pacific, having effected a junction with that road at Billings, Montana, yet with rumors of its own extension to the coast. It was the part of wisdom to utilize existing roads to the fullest rather than to build new ones, to combine the two roads that paralleled each other and had absolutely identical interests, and to control the "Burlington" which at once afforded a direct outlet for Washington lumber to all the treeless central states, eight or nine in number, and also with terminals at St. Louis, directly connecting it with many of the southern cotton roads. Therefore with dramatic unexpectedness the Northern Securities Company was formed, identifying these three roads, with the deliberate intention of diverting the cotton exports of the United States to Asia by way of Atlantic and European ports to the ports of Puget Sound. The temporary and apparent rivalry between the combination of the northern and of the southern roads was but an episode. It is not a question as to whether

ROSLYN COAL WHARVES, SEATTLE.

Puget Sound ports shall not be favored in transcontinental rates compared to San Francisco, or whether the Great Northern shall carry fruit from Southern California to Chicago, but whether the unlimited trade of eastern Asia shall pass to Europe by Pacific American steamers and American railroads, or continue to go by way of the Suez canal.

From its first building and down to the present time, the Panama Railroad has been able to compete with the all-ocean route in handling freight between the Pacific and the Atlantic coasts. The European mails and passengers already go from London to eastern Asia by way of Canada, because it is shorter and there is a saving of ten days in time. The limits imposed on cheap freight traffic from Europe to Asia are:—

1.—The tolls through the Suez Canal.

2.—The size of ships that can pass the Suez Canal.

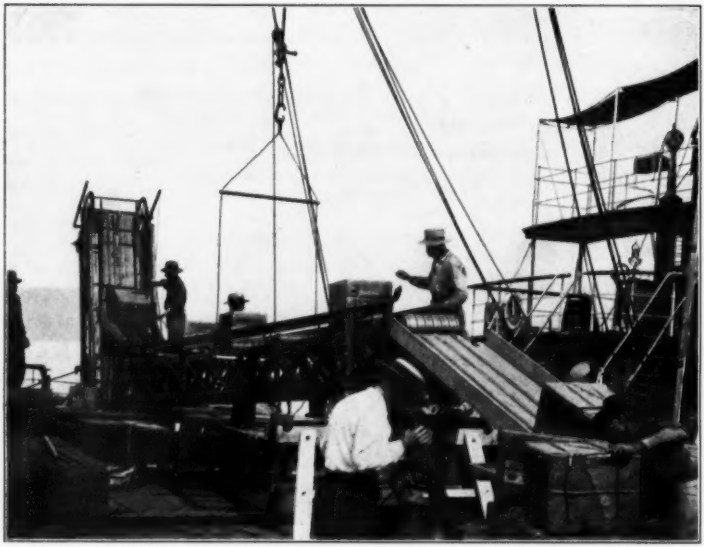
3.—The cost of coal along the route.

4.—The distance.

Tolls may be abolished, but this is not likely; it will take years to deepen the canal even if this project should be advocated; the cost of coal along the route, as well as the distance, will always be a drawback. The only limit to the size of ships that can be put on the Atlantic is the depth of the harbors on both sides.* This limit does not exist in the Pacific, where Puget Sound has 400 to 500 feet of water within a cable's length of the shore. There is abundant and cheap coal in Great Britain, on the Atlantic seaboard, on Puget Sound, and all along the line of the northern roads, and there are an unlimited number of empty freight cars west-bound. By building the largest ships in the world, even though they run under the more expensive

* Mr. Robinson's article following deals with the engineering aspects of the very important work of enlarging this limit by deepening the harbors.

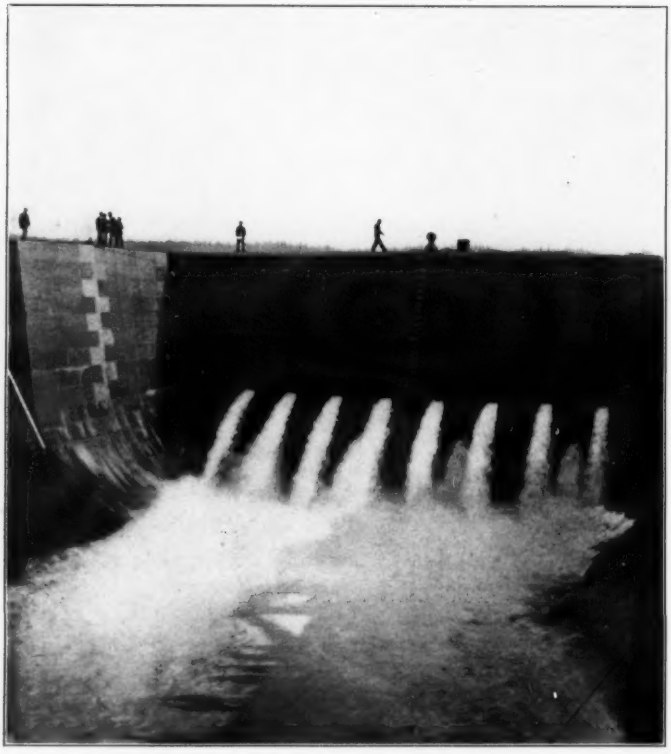
Interior of new wheat warehouse, Tacoma.



Portable conveying machinery unloading tea, Tacoma wharves.

S. S. OREGON IN FLOATING DRYDOCK, MORAN BROTHERS COMPANY, SEATTLE.

American register, by filling the west-bound cars at a rate litttle more than the cost of handling, Mr. Hill knows that he can turn the export trade with western Asia from its three-hundred-year old way past India to the direct Pacific sea route past Alaska. Before these new ships were ordered, experts were sent to Scotland, Ireland, and Germany, to absorb all that could be learned of modern mammoth ship building; and to escape from all hampering traditions of the past, an entirely new company, the Eastern Shipbuilding Company, was formed to construct



FLOODING THE DRY DOCK, PUGET SOUND NAVY YARD.

them and took the contract before even the site was purchased on which the new yards were to be established. These steamers are 630 feet long, 73 feet wide, and on draught of 36.5 feet will have displacement of 37,000 tons. The navigating deck is 90 feet above the keel. Each steamer can carry 1,200 troops, and the cargo capacity exceeds 20,000 tons. Some of the hatches are large enough to admit a complete locomotive. With a horse power of 11,000, a speed of 14 knots will be maintained. To accommodate these steamers enormous docks and warehouses are being constructed at Seattle, both wharves and warehouses of gigantic size already existing at Tacoma. Cotton baled by the Lowry compress weighs 45 pounds to 50 pounds to the cubic foot, and 400 to 500 large freight cars loaded with these bales will furnish cargo for one only such steamer. The total cotton exported

in 1900 was 1,500,000 tons, much of it to Europe for direct or manufactured export to the millions of Asia. These have now made a notable beginning in the manufacture of their own cotton cloths, and increasing quantities of American cotton will be sent direct to them.

Before these ships are launched, in connection with the Boston Steamship Company—which operates the Shawmut and Tremont, twin-screw steamers of 9,600 tons and 15-knot speed, and also the three smaller steamers, Hyades, Pleides, and Lyra—the northern railroads have quoted a rate of $8 a ton for the transport of Government supplies from Chicago to the Philippine Islands, of which the railroad share is $3.75 per ton. Return rates have been quoted on wool from Australia and New Zealand which make it probable that the imports from British Australasia to Boston, New York, and Philadelphia will come by the Pacific overland route instead of through Suez.

There are few more striking facts than the growing importance of the Puget Sound customs districts. In the year that has just closed all the customs districts of the United States showed a decline of exports of grain and grain products except the Pacific Coast ports, the shipments from the Sound increasing 45 per cent.

S. S. WILLAMETTE ON MARINE WAYS, MORAN BROS. COMPANY'S SHIP-YARD, SEATTLE.

From an American point of view there is one shadow in this bright light of future American supremacy on the Pacific, and that is the rivalry of the Canadian roads to the north. One of these already in full operation, the Canadian Pacific, runs from ocean to ocean. The other, the Grand Trunk, is now building to Port Simpson, the most northern seaport in British Columbia. Both these roads command rich wheat belts; both of them tap exceedingly rich and very good coal fields; both of them as they approach the Pacific Coast pass through timber lands of the same general character as the heavy forests of Washington and Oregon. The Grand Trunk will have six advantages over all its American competitors. It will stretch from Atlantic to Pacific under one management and can make its own through rates, while none of the American roads extends further than Chicago, and it will further control ocean-steamer connections at both ends; it will be the latest built road, with latest and most consistent equipment; its Pacific terminus, Port Simpson, a magnificent harbor on the Alaskan border, is nearer by 500 miles to Asia than is Puget Sound or Vancouver, yet the road itself is as short as any other transcontinental line;

PACIFIC COAST S. S. COMPANY'S STEAMERS AT THE SEATTLE WATERFRONT.

it escapes entirely the climb and heavy grades over the Rocky Mountains, which do not extend as far north as its line; its wheat belt extends from Manitoba unbrokenly to a region that is west of Vancouver, a gain in local agricultural lands of nearly 1,000 miles over the American lines; and it will by the location of its terminus monopolize the whole of the enormous and rapidly growing Alaskan traffic.

Great and serious as this competition will eventually prove, several years must elapse before it is felt, and this respite should be utilized by the American roads to build up local, through, and international

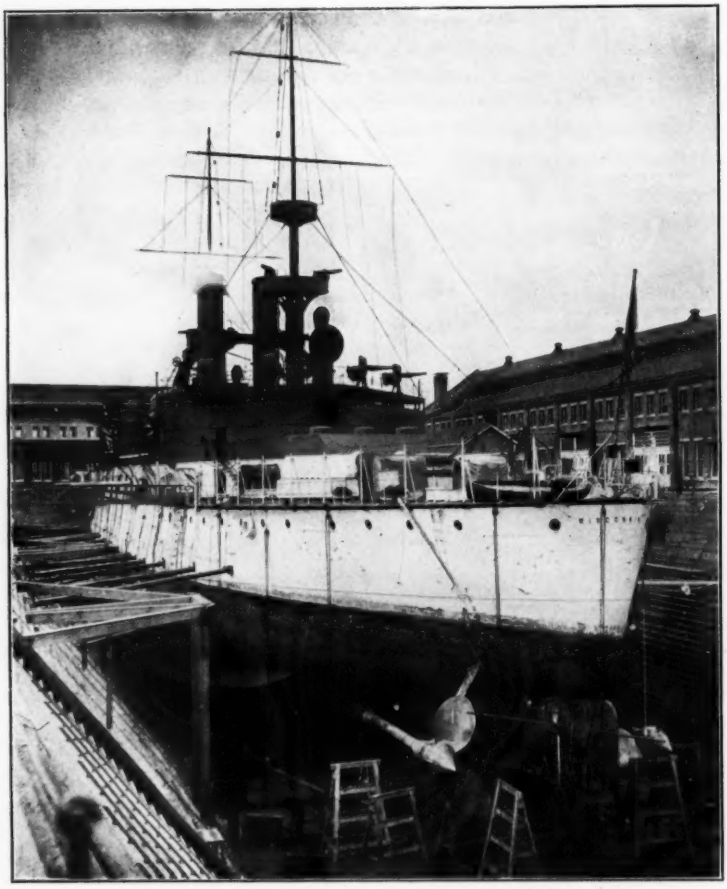
traffic, so that an ever decreasing freight rate will, through an ever increasing tonnage, augment the total receipts. Also new economies of intensive operation, as yet almost untried in railroading although successful in other modern industries, can at least double the present efficiency and per dollar of fixed charges carry twice as much freight, without lowering wages or adding to cost. Roads so managed and so

PUGET SOUND PASSENGER STEAMERS AT THE SEATTLE WATERFRONT.

developed will need to fear no rival, whether it be a deepened and toll-free Suez Canal, a Panama Canal, a modern railroad at Tehuantepec, or one great wheat farm from Winnipeg to Fort Graham.

The heavy capitalization and the merger of the northern roads will in the end prove advantageous, not only to them but in far greater degree to all the people of the United States, as it will necessitate the development of every local resource, and also bring about a diversion of the world's Oriental trade from the Atlantic to the Pacific, from European to American control, and thus quicken into being a thousand industries not yet conceived.

To this beneficent stimulus all the country will respond, most of all the younger commonwealths of the Pacific Coast, with their flourishing seaboard cities each with its own particular advantages of location and environment. San Francisco will long remain the queen city of the west. Not only has she the lead over all rivals in age and accumulated wealth, but she is the central city, with innumerable tributary manufacturing establishments, with local steamer lines running southward to Panama, northward to Alaska, westward to Hawaii, already



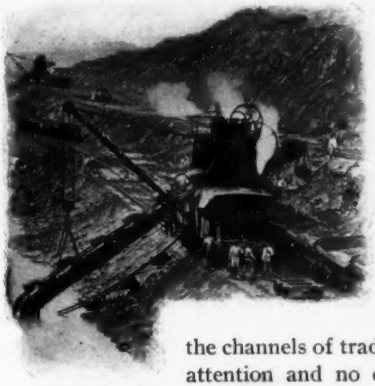
U. S. S. WISCONSIN IN DRYDOCK AT PUGET SOUND NAVY YARD.

connected by the only trans-Pacific cable. San Diego is the nearest of all Pacific cities to Panama, nearest also to the Atlantic waters, nearest to Samoa, Australia, and New Zealand. Portland, the Philadelphia of the west, a terminus for both the great combinations of the railroads, the northern and southern trans-American lines, will have a double opportunity for future growth. Seattle and Tacoma, with world interests that are identical, are nearest to Alaska, Japan, and the Philippine Islands, have the best harbor in the world, and unlimited coal resources. There will be business and to spare for all of them.

MODERN MACHINERY FOR EXCAVATING AND DREDGING.

By A. W. Robinson.

We have more than once quoted the dictum that the only limit to feasibility in engineering work is the cost of execution. This limit the genius of the engineer is constantly pushing farther and farther away—very strikingly in the field of work with which Mr. Robinson deals. The huge tools he discusses are those by which the engineer reshapes not only the seas and the hills, but the very flow of commerce and civilisation. They are the mechanical elements in so vast and wide-reaching undertakings as the Panama Canal, or the land routes reviewed by Mr. Emerson in the preceding paper. And their general influence on the economy of transport and distribution of wealth are brought out by Mr. Robinson in his opening paragraphs. The present article deals more particularly with machines for cutting the roadways of internal transportation. A second will take up the heavier types more closely adapted to harbor and ocean waterways.—THE EDITORS.



IT is recognized by thoughtful people that commercial supremacy is obtained and held by that nation which has the best developed and most economical transportation, both internal and with other nations. What is true of nations in this respect is true also of local communities, in so far as their advancement and well-being are promoted by facility of interchange. The development of the channels of trade now occupies a large share of public attention and no question is more important or more vitally affects commercial prosperity than does transportation.

It is proposed in this paper to describe some of the modern mechanical methods by which the pathways of transportation by sea and land are made, and to show what great possibilities are in store in the immediate future, when the development that is now going on shall have become further advanced.

The fact that increased economy is obtained by increased size and capacity has caused a wonderful advance both in the size and power of water-borne vessels, and in the rolling stock of railways. The same cause has operated to bring about a rapid growth in the power and

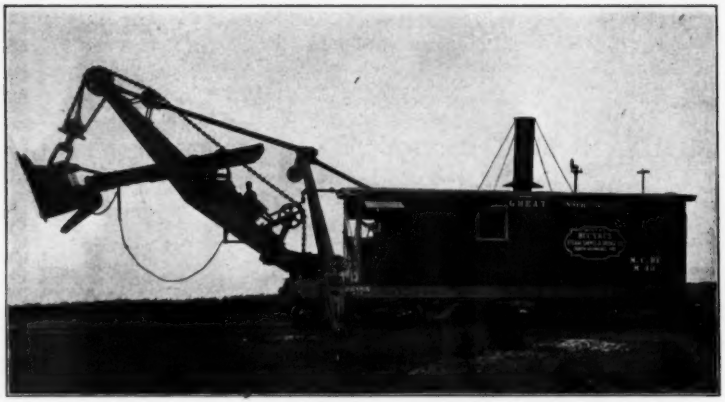


FIG. I. RAILWAY STEAM SHOVEL, DIPPER 2½ YARDS CAPACITY.
The Bucyrus Company, South Milwaukee, Wis.

capacity of dredges and steam shovels. In ten years the paying load carried by a representative ocean cargo steamer, and by a representative freight train, has about doubled, and a similar rate of increase is observed in the capacity of dredges and steam shovels. It is safe to say that this growth will continue, limited only by the conditions of each case. The limiting condition in the size of steamships is only in the capacity of harbours and channels and the means of supplying and trans-shipping cargo.* The limits to the size of a dredge are only in the magnitude of the work it may have to do to insure that it shall be profitably employed for a sufficient length of time, and also in the facilities for disposing conveniently of the material dredged. The limit to the size of a railway excavator or steam shovel is only that of gauge of track and clearance limits and the capacity of cars to receive and haul away the material. It will be seen that within these limits great possibilities exist, and also that the development of the modern high-powered dredging machine will render possible great works hitherto unthought of, and by deepening channels and harbours will remove the most serious limitation to the growth of the steamship and consequently to the economy of sea transportation.

There is also the mechanical limitation. That mechanical science

* The importance of this will be realised when the comparative economy of small and large steamships is considered. Thus the cargo steamer of ten years ago carried 5,000 tons of paying cargo at 10 knots on 8 pounds of coal per ton per 100 miles. The Celtic can carry 20,000 tons of cargo at 17 knots on 4 pounds coal per ton per 100 miles. (See "Economy of Large Ships," *Trans. Can. Soc. C. E.*, Nov., 1902.)

will be equal to all demands upon it cannot be doubted. Experience proves that whatever is feasible or desirable from a commercial or economic standpoint, can be successfully built from a mechanical standpoint. The growth must be gradual, even if rapid, and built upon the lessons of previous practice. Also experience proves that the highest engineering skill is needed if costly mistakes are to be avoided.

Turning first to the question of land transportation, the machine that has performed the most useful work in preparing the pathway for the railway is the steam shovel, or as it is called in Britain, the steam navvy. The necessary cuts and fills of a railway line are made very cheaply by these most useful machines. It is natural that the steam shovel should find its largest development in America, where railways have to be built cheaply over long stretches of country and where the cost of manual labour is high. A modern shovel for railway purposes is illustrated in Figure 1. This shovel was designed by the writer and built by the Bucyrus Company, of Milwaukee, Wis. It has a steel frame throughout and the car body is 10 feet wide by 40 feet long. It handles a dipper of 3½ cubic yards capacity four times a minute, so that in a good bank when it can fill its dipper the rate of work is 14 cubic yards per minute. It can make a cut 55 feet wide and dump its load 16 feet above the rail. It is worked by a crew of three men on the machine and two to five labourers in the pit, and the coal consumption is

FIG. 2. RAILWAY GRADE REDUCTION BY STEAM SHOVEL. MARION "MODEL 98."

about 1½ tons for 10 hours. The shovel illustrated has a record of 5,880 cubic yards of gravel loaded on cars in 12 hours, and 45,000 cubic yards in 9 days.

To make the great capacity of this shovel available it is necessary

FIG. 3. STEAM SHOVEL AT WORK AT GRADE REDUCTION, WISCONSIN CENTRAL RAILWAY.

to provide car service of large capacity and as nearly continuous as possible. Trains of 25 cars, each holding 20 or more cubic yards and hauled by powerful locomotives, are now used and served past the shovel on a through track, and as soon as one is loaded its place is taken by a second train. The cars are either of the dumping pattern or are unloaded by a "plough" convering the width of the car and hauled over the entire length of the train by a wire rope, this being an operation of a few minutes. In this way the material of a "cut" is transferred to a "fill" at the rate of 3,000 or 4,000 cubic yards per day and at a cost of 4 to 8 cents per cubic yard, including haulage for a short distance.

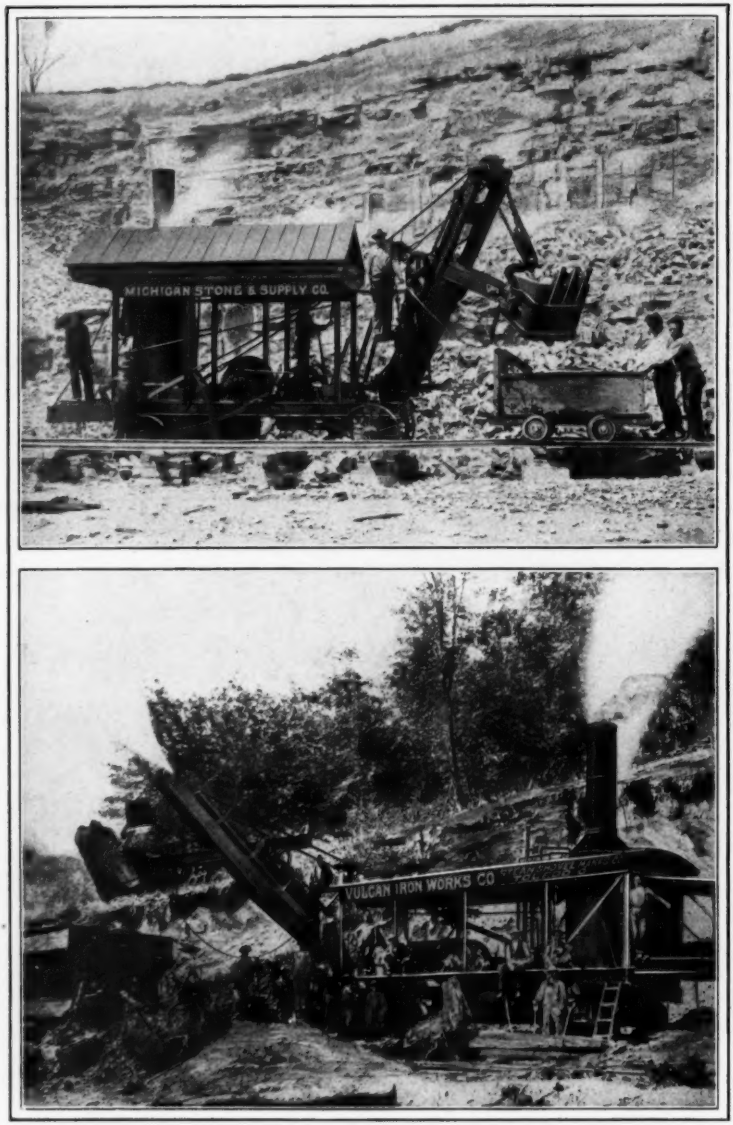
In Figures 2, 3, and 4, are shown several views of grade-reduction work by steam shovel. The size of the cut made and the manner of working the trains of cars are clearly indicated. So important a bearing has a straight and level road bed upon the economy with which loads can be hauled, that the older railways are expending vast sums of

money upon reduction of grades and straightening of curves. Thus not only in the building of new roads but in the improvement of old ones, the steam shovel finds an ever-growing field of usefulness. In the great iron-ore ranges also the modern method of mining by the steam shovel has been a most important factor in the economy with which American steel is produced.

The American type of shovel differs from the British navvy, in that it is part of the standard rolling stock and can be coupled in a train for transportation, whereas the British machine is usually mounted on four rigid wheels. In addition to convenience for transportation the double trucks of the American machine have the advantage of greater flexibility and distribution of load on soft or uneven ground, and allow it to work more readily on curves. The American shovel has powerful independent engines for swinging the boom and feeding the dipper, and its movements are very fast.

FIG. 4. RAILWAY GRADE REDUCTION BY STEAM SHOVEL, WISCONSIN CENTRAL RAILWAY.

In America there is very little variety in the general type of shovel used. The French and German types of endless-chain machines find no favour. They are considered to be heavier and more cumbersome; they cannot adapt themselves to a wide range of conditions; they re-



FIGS. 5, 5A. STEAM SHOVELS AT WORK.

The upper figure represents a ¾-yard dipper handling broken rock. The lower one shows a 1½-yard dipper on railway work, loading into Goodwin cars. This shovel will dump 13 feet from the track. Capacity 1,500 cubic yards a day.

Vulcan Iron Works Co., Toledo, O.

quire a well laid straight level track of five rails to work on, and they are adapted to load only small cars that will go through the tunnel of the machine. They are inferior to the American type in point of ability to deal with obstructions such as boulders and stumps and to work in rough and irregular ground, and the wear and tear of a chain of buckets and links is very great. On the other hand, it is claimed that as they stand on top of the bank instead of in the bottom of the pit, they have the double advantage of being independent of seepage water, and of requiring less locomotive power to haul away the loaded trains.

One of these machines is shown in Figure 6a (next page) as built by the Lübecker Machinenbau Gesellschaft, of Lübeck, Germany.

FIG. 6. STEAM SHOVEL LOADING BLASTED ROCK, PENNSYLVANIA RAILROAD.
Marion Steam Shovel Company.

Some shovel builders have endeavoured to improve the strength and capacity by great weight and have brought out machines weighing 90 to 100 tons. This is a mistake. In a locomotive great weight is necessary for adhesion, but in a shovel strength combined with lightness should be the aim, and lightness also contributes to speed.

At the present stage of development the representative American steam shovel for railway use carries a dipper of 3½ to 4 cubic yards capacity and weighs about 75 tons (150,000 pounds). Shovels of 5

cubic yards capacity have been built. Ten or twelve years ago the standard railway shovel had a dipper of 1½ cubic yards and the weight was 35 tons. Improved designs and the use of steel instead of cast iron have done much to increase efficiency, but much improvement still remains before the steam shovel is lifted to the plane of the locomotive in point of careful and scientific design, perfection of detail, and reliability in service. The indications are that for shovel work, chain will be superseded by wire rope and greater speed and power obtained, and also greater reach and lift; but that the size of dipper will not be further increased—at least for railway work. Also steam-pressure will be increased and the shovel generally built on locomotive lines as to design and quality of workmanship.

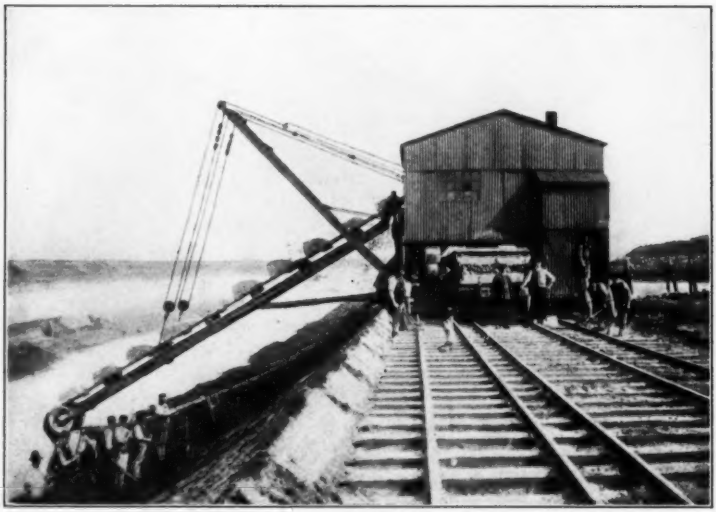


FIG. 6A. ENDLESS-CHAIN ELEVATOR AT WORK ON MANCHESTER SHIP CANAL.
Lübecker Maschinenbau Gesellschaft.

Coming now to water transportation, we find a wider field and a great variety of machines for dredging and disposing of material. Within the limits of this article it will not be possible to do more than touch upon the leading types from the American point of view, with some examples of each, and give some notes on the causes and conditions which have led up to the present state of the art.*

* In this article the term "American" is used to mean the North American Continent, and not only the United States, and "European" is held to include Britain.

The four established types of dredges are:

1.—The ladder dredge, with chain of buckets.

2.—The dipper dredge, with single dipper mounted on a handle.

3.—The hydraulic or suction.

4.—The clamshell or grapple.

The first type or ladder dredge is most widely used in Europe and from thence sent abroad, but finds little favour in America. In Mr. Corthell's article on European sea-going dredges published in this Magazine, in April and May, 1898, several machines of this type were

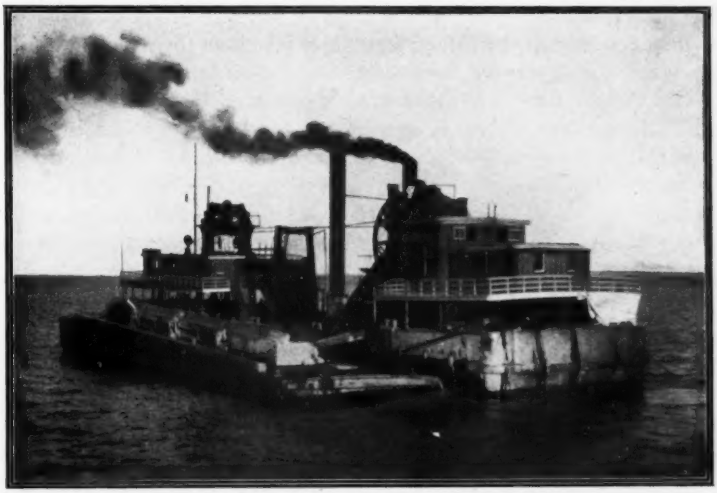


FIG. 7. ELEVATOR DREDGE ABERDEEN, ST. LAWRENCE RIVER.

illustrated and therefore they are not fully gone into here. In that article the lack of such machines in America was taken to indicate a general backwardness in the art. I do not think this altogether a fair conclusion. It is quite true that in large sea-going dredges America has been and is still behind Europe, both in point of numbers and general excellence of design and completeness of equipment.*

The reasons for this are twofold:—first, European seaports had a long start of American, and their commerce with the rest of the world was for many years more important and had an earlier development; and second, the methods of administration followed in Europe favoured the creation of permanent plants to execute works gradually

* Although in other ways America excels, as will presently be shown. In the four years since 1898 dredges have been built in the United States and Canada which hold the world's record for size and performance, data of which will be given in the second article.

carried out on a comprehensive plan at large cost. In America works of this class are under the control of the Federal Government, and are for the most part executed under the small-contract system, according to appropriations voted by Congress; and the main work has been, up to the present, the development of a vast interior country, the seaports receiving comparatively little attention. America is now turning greater attention to seaport improvements, and the development of modern dredges of high power and efficiency may be said to be in its transition stage. While some large and modern dredges are now to be found, most of them are still of small size and of cheap and temporary construction and show no regular system in their design. This is due in part to the small-contract system already referred to, under which the contractors of different localities have developed machinery and plant of their own suited to their needs and resources, and in which low first cost and the successful completion of their contract were the main considerations. Older contractors, with more money and experience, developed better tools along the same lines, but there is always the chance of a novice coming along, taking a contract, and building cheaper and more experimental plant to do it with.

This system was probably the best for early American conditions. It would be impossible to develop a vast interior country like that of America without carrying on a great number of small and widely separated works under the contract system. Under this system the Government gets the advantage of competition, and usually gets the work done for less than it could by building and maintaining a plant. The contractor builds cheap tools which he can readily take from place to place. These are sometimes special and thrown away at the end of the job, and if more permanently built must be of a design adapted to all kinds of work. He has to pay high wages—about double those for similar work in Europe—and he contrives to accomplish results with his apparently rude and ill-kept plant which would astonish some of the large corporations with their costly and elaborate outfits.

On the other hand, it must be said that the small-contract system has worked disadvantageously for the development of dredging machinery in America, from an engineering point of view. The small contractor gets up his own plant largely by rule of thumb, and is rarely an engineer, and his designs are arrived at by a process of elimination of weak points, and patching up a machine which was crude and ill-designed in the first place. He is limited by questions of first cost and the uncertainty of future contracts. His experience is limited to his own work, and his knowledge is acquired by hard knocks and costly

mistakes, which he tries not to repeat, by making the part that broke stronger than it was before, instead of adopting a better design.

In the United States a change has taken place which is having an important effect in producing larger and more efficient plant. The expansion of commerce has made necessary works of greater magnitude, and the Government has adopted the policy of letting larger contracts, sufficient to justify a contractor in building a plant and to allow him time to do it.

Why do we find European dredges principally of the ladder type and of large and complete construction, with steel hulls, while in America we see none of them, but in their stead we find cheap wooden

FIG. 8. ELEVATOR DREDGE WITH LARGE BUCKETS FOR SOFT MATERIALS, ST. LAWRENCE RIVER.

dredges of other types which apparently suffer by comparison? The answer to this question is found in the later development of American seaports, and in the small-contract system as already pointed out.

The development of the country by small and widely scattered works necessitated small and cheap machines, and thus developed the dipper and clamshell type which suited the conditions better. The American contractor was not going to purchase a steel ladder dredge, costing say $100,000, which would do 3,000 cubic yards a day with a crew of fifteen men, and which required a repair shop to keep it going,

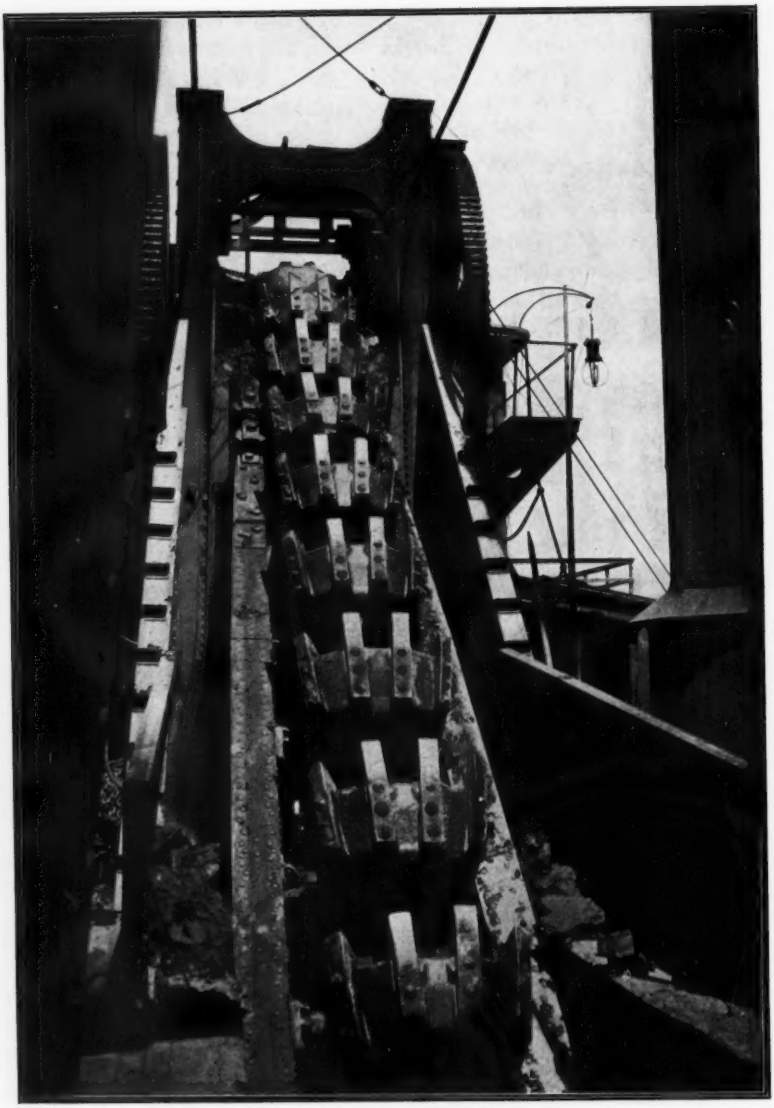


FIG. 9. ELEVATOR DREDGE WITH BUCKETS FOR HANDLING ROCK, ST. LAWRENCE RIVER.

when he could build a wooden clamshell or dipper dredge for $50,000 that would do about as much work under his conditions with a crew of ten men and half the repairs. Permanence was with him no object; he must make money now. In a year or two his dredge would be either worn out, obsolete, or both; he might have a different contract, and would let the future take care of itself.

This is not far from the truth even now, although conditions are rapidly changing. The older and more wealthy contractors are building larger, more permanent, and more efficient plant. The Governments are building larger and more costly dredges. Works are on a greater scale, and we may expect to see a very much better class of plant.

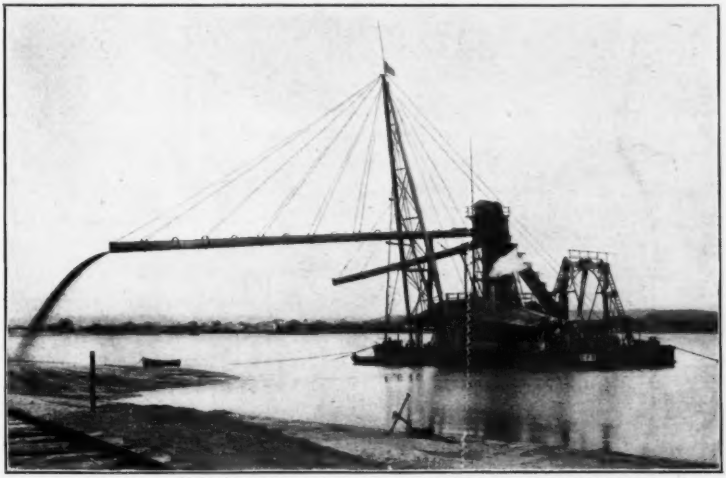
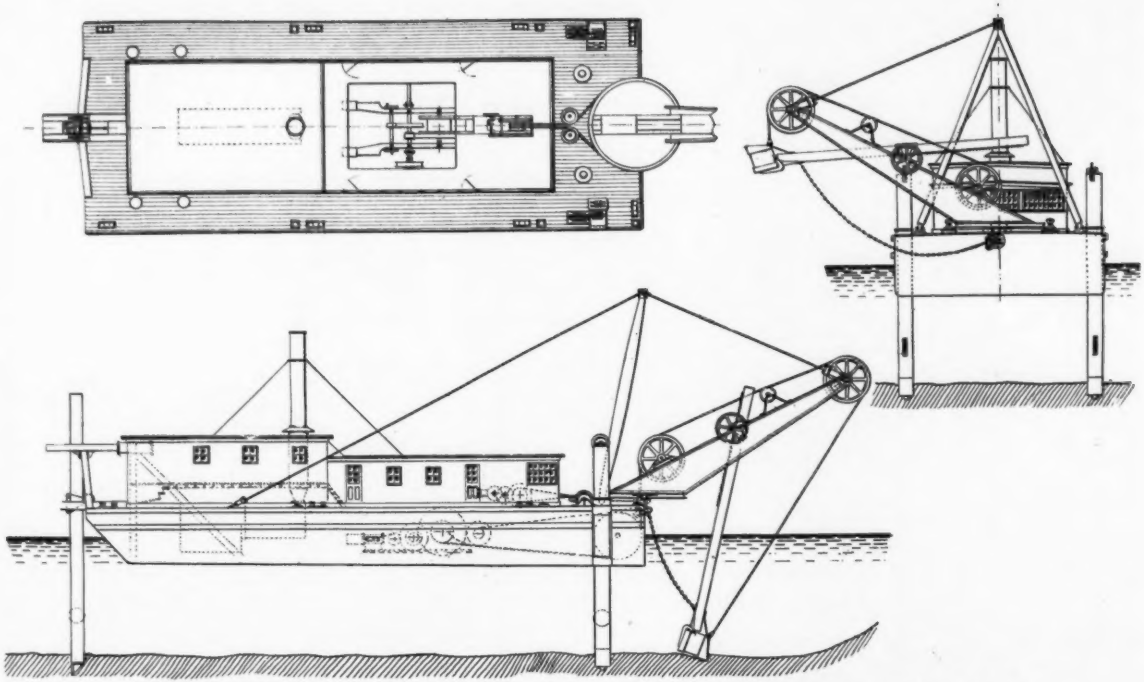


FIG. 10. HIGH-TOWER ELEVATOR DREDGE WITH GRAVITY DISCHARGE.

In Canada, the Federal Government carries on its river and harbour improvements directly through the Department of Public Works, owning and operating its plant and doing but little work by contract. Dipper dredges are mainly used on the lakes and interior, but we find a number of very efficient ladder dredges on the River St. Lawrence ship channel which are the lineal descendants of early dredges of this type imported from the Clyde as far back as 1832. One of these dredges is illustrated in Figure 7. Some of them have large buckets for soft materials, as in Figure 8, and some are fitted with powerful rock-cutting buckets, as in Figure 9.

Vessels drawing 28 feet now come to Montreal, though the original depth was only 10 feet. This is accomplished by 55 miles of



FIGS. 11, 12, 13. SIDE ELEVATION, PLAN, AND END VIEW OF 4½-YARD DIPPER DREDGE FOR THE GREAT LAKES.
Scale about 1/24 inch = 1 foot. A. W. Robinson, Mechanical Engineer. See page 860.

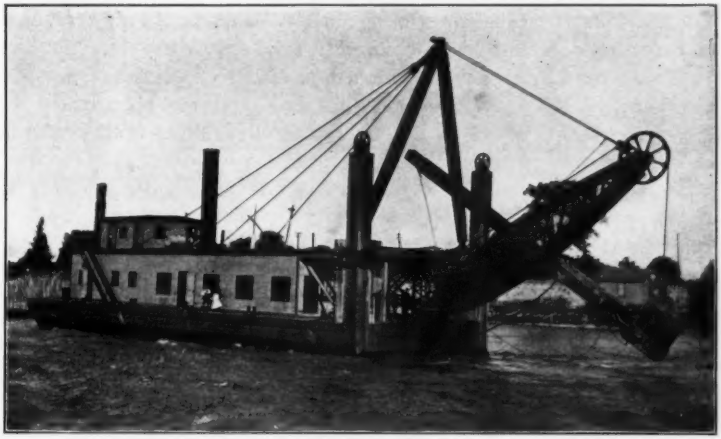


FIG. 14. 6-YARD DIPPER DREDGE ON THE GREAT LAKES.
Hull 120 by 42 by 12 feet. Built by the Bucyrus Company.

dredged channel and the removal of 40,000,000 cubic yards of material. One of these dredges as far back as 1886 made a record for economy which has since been rarely equalled. This was the dredging and depositing of 886,710 cubic yards of blue clay at a total cost of $25,723, or 2 9/10 cents per cubic yard.*

In Figure 10 is illustrated a high-tower elevator dredge, with gravity shore discharge. This illustration is given to show a type of dredge that is practically obsolete. There is hardly any condition in which it could be used that the work could not be better done by a hydraulic dredge, whether for original dredging or for re-handling. The dredge in the illustration elevates the material to a useless height and deposits it so near the edge of the water that much of it runs back again. If it could deposit it dry, it might stand up in a bank; but water must be used to flush the inclined chute. Nevertheless this type of dredge was largely employed on the Suez Canal, and is still used there for maintenance work. The large dredges used on the early Panama Canal by an American contracting company were also of this type and were illustrated in the journals of the day. They had steel towers 50 feet high and a chain of buckets of one cubic metre capacity each, and certainly did effective work for that period. The same difficulty was present—that of depositing the material on the bank in such a way that a large portion of it ran back again into the cut. It is

* See Reports Harbour Commissioners of Montreal, 1886, p. 80.

notorious that these machines dredged the same material over a number of times and got paid for it each time.

I have used the ladder type of dredge extensively in my own practice when conditions warranted it, but as a type it is not adapted to general service conditions in America under the contract system, although it could be used to good advantage on seaport or ship-channel work where the material is other than sand or soft mud and where it could be guaranteed suitable work for a series of years. In sand the centrifugal pump is found to be the best type for economical work, and in mud or silt which is soft and easy to dredge the clamshell or grab of large capacity is a simple and cheap machine giving good results.

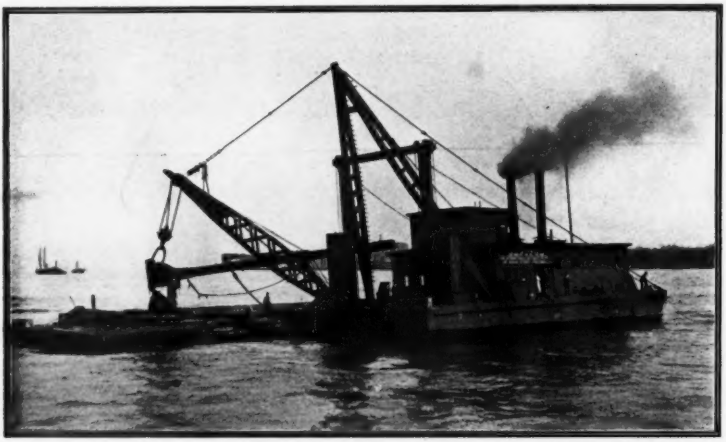


FIG. 15. 6-YARD DIPPER DREDGE AT WORK IN NEW YORK HARBOUR.
Built by Osgood Dredge Co., Albany, N. Y.

America is now passing out of the wooden stage into the steel stage. Good timber is increasingly more difficult to get, while steel is relatively cheapening. Many old dredgemen still regard steel with suspicious eye and wonder whether a steel scow or steel dredge will work as well as wood, and how they will be able to repair it. In the dipper type of dredge the spuds and dipper handles are still made of wood, and defy the steel ones, which lack the springiness and cannot keep their rivets tight. The home of the dipper dredge is on the Great Lakes. There it flourished and in the smaller sizes and in non-tidal fresh water at 20 feet depth was marvellously efficient. A good wooden dredge of ten years ago which cost say $30,000, would do 1,500 or 2,000 cubic yards per 10 hours with a crew of six men on 3 tons of coal.

FIG. 16. 12-YARD DIPPER DREDGE EMPTYING INTO 1500-YARD SCOW, HUGHES BROS. & BANGS, NEW YORK HARBOUR.

FIG. 17. ROCK CUT, CHICAGO DRAINAGE CANAL. CANTILEVER CONVEYORS AT WORK.
Brown Hoisting Machinery Company.

FIG. 18. CANTILEVER CONVEYORS BUILT BY BROWN HOISTING MACHINERY COMPANY AT WORK ON CHICAGO DRAINAGE CANAL.

It could lift its spuds, move up, and reset again in 90 seconds. It stands alone like a table on its legs, with no moorings to obstruct navigation. By means of its dipper on the bottom it can move itself about crab-fashion in any direction, and by the same means can push the barges about which it is loading. It can manœuvre itself in any direction, load scows, dig foundations, pull piles, lay concrete blocks. deposit back-filling, lift boulders, raise wrecks, dredge hard or soft material, and do nearly everything but vote. Its great simplicity made it light in repairs. With tools like these, and suitable for their work, the marvel is not that American contractors do not use the big and costly European ladder dredges, but that these useful American tools do not find a wider recognition in Europe and abroad.

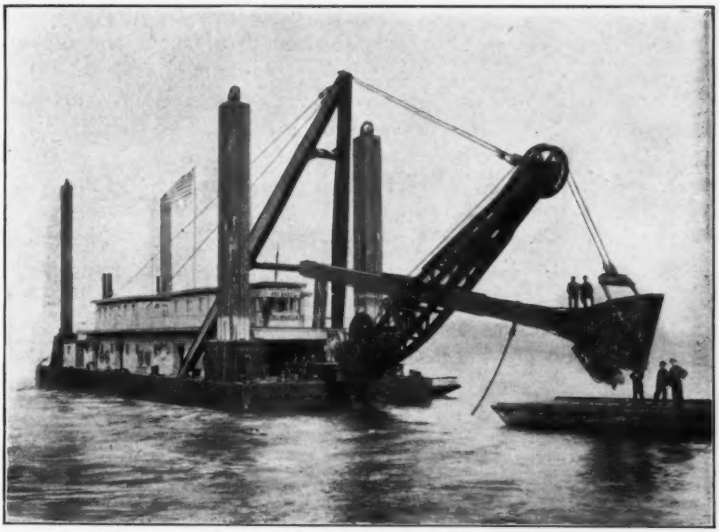


FIG. 19. THE 12-YARD DIPPER DREDGE ONONDAGA.
Hughes Bros. & Bangs.

It must be said that American practice in dipper dredges lacks uniformity and system. An engineer from abroad would find it very difficult to gain a fair impression, as no two machines are alike and many of them are very poor. In appearance, likewise, they are very deceptive. Many an ambitious dredge of good appearance, were its true history known, would make a poor showing of results, while on the other hand a clumsy, wooden, mud-bespattered rival in good hands will jog along steadily and make money for its owners.

On the seacoast conditions are different from the Great Lakes mainly because sea water at 40 feet depth is different from fresh water at 20 feet. The clamshell type prevails, mainly because more of the material is soft, and because this type, straining its spuds less, is better adapted for the deep tidal work, as compared with the work on the Great Lakes. The present standard depth for channels and harbours on the Great Lakes is 21 feet, except Lake Ontario, where it is 14 feet. No immediate increase of this standard is contemplated, as any increase to be effective must embrace the whole chain of lakes. A class of vessel has developed to suit the navigation conditions on the lakes which has grown to enormous proportions in numbers and value. The dipper type, however, is used also on the coast to some extent, as it can dredge harder materials; but the great depth now required for seaports is an increasing tax upon the strength of spuds and dipper handles of this type, as also upon a ladder and chain of buckets.

Modern tidal dredges must now work to 45 feet and the writer has designed one which is intended for hard material in 60 feet of water. This is made necessary by a tidal range of 25 to 30 feet. For great depths the clamshell and suction type have the advantage over the other two types, provided the material is suitable.

The modern type of dipper dredge of the Great Lakes is illustrated by two examples from the writer's designs, a 4½-yard dredge and a 6-yard dredge. The first named is illustrated in outline in Figures 11, 12, and 13, and was built in 1902; the second, Figure 14, was built in 1899. The dredge, Figure 14, was built for M. Sullivan of Detroit, Mich., by the Bucyrus Co., of South Milwaukee, Wis. A duplicate of it was built in 1900 for Daly & Hannan of Ogdensburg, N. Y. As an example of the value of simplicity of type and good detail, the total delays of this dredge during the season of 1901 on account of repairs were only 2 per cent. of the total working time. It has a wooden hull 38 feet by 110 feet by 12 feet. The hull is stiffened by a steel truss. The main hoisting engines exert a direct pull of 120,000 pounds upon the dipper. The dipper is 6 cubic yards capacity and in ordinary material can be worked at a speed of two dippers per minute in 20 feet of water. This speed is rendered possible by the great power and speed of the hoisting engines, and by the adoption of a single part of hoisting rope, which permits the dipper to drop at nearly the velocity of a falling body when released. All motions are performed by friction and without manual effort on the part of the operator. The forward spuds are single timbers of Oregon pine 36 inches square, operated by wire rope from the main engines.

THE MANAGEMENT OF METALLIFEROUS MINES.

By Albert Williams, Jr.

In preceding articles (THE ENGINEERING MAGAZINE for January and February) Mr. Williams discussed the management of metal mines from the viewpoint of the superintendent. The present paper deals in some detail with the relations, duties, and qualifications of the expert force through whom the manager directs and controls the whole working. Suggestions are offered for efficient division of work and responsibility and for economies by combinations and reductions in the staff personnel.—THE EDITORS.

TO a certain extent what is here said applies to colliery organization also. There are obvious differences in requirements between the two classes of mines, but the general idea is the same throughout.

Of course the presence of a staff implies the existence of a mine of some importance to warrrant it. For convenience it is assumed that the mine is a large one, productive, and with a large force. From the extent of individualized functions here noted a somewhat alarming impression might perhaps be drawn as to the number (and pay) of assistants to the superintendent, but the due combinations and eliminations can readily be applied to meet any particular case.

Proportioning the staff (with its salaries and complex relations kept in mind) is a matter of nice judgment—often hinging upon financial possibilities rather than purely technical advantages. Its number, expense, and character depend not only on the extent of workings, labor employed, and prosperity, but also on whether the kind of ore handled calls for great or small or varied technical attainments. A big precious-metal mine (gold, silver, or both) with some sort of metallurgical plant attached, exemplifies the most involved organization; but the great copper and iron-ore mines also are intricate affairs. As a general and safe rule the staff should of course be limited in number to what is strictly necessary to smooth running without penny-wise skimping. It should at any rate not be top-heavy, which is quite as bad as being short-handed. There are several ways of economizing, without lessening the total efficiency, which will be considered later.

The staff at the mine gradually shades off into what might be called the petty-officer rank, and it is almost as hard to define just where to draw the fine line between "expert" and "skilled" in the office and

outside force as it is between the skilled and ordinary labor—for all real miners need skill in varying degree. Perhaps the best division is on the score of authority. Then besides the regularly employed local staff there may be temporary expert help, and under some conditions an arrangement for joint employment and pay of certain men by companies operating neighboring mines.

Of the regular staff, first comes the assistant superintendent. His duty is to act as executive officer and represent the superintendent or manager in authority, on occasion, while always relieving the latter of all details possible. What is here wanted is fair all-round technical ability rather than much experience, being under the guidance of an older mining man; and the suggestion at once arises that a young and ambitious graduate from a mining school, willing to serve on a moderate salary in view of the opportunity for observation, practice, and future promotion, would about fill the bill. In case the appointing power has no special person in mind, it would be well to consult the head of one of the leading technical schools, asking him to recommend a suitable man, on the strength of his school record and other qualifications. This the school people are always glad to do, and with discretion, for the sake of the reputation of their institutions.

In earlier times the mine foreman filled this berth, and does so yet in many instances; but the other plan is more satisfactory, and the foreman can find plenty of occupation as it is. There is this disadvantage, that the older and more experienced men do not always like to take orders from a younger person with less "practical" knowledge; so that the "kid" (as he is likely to be named) will need all the tact and reserve he has, and should be chary of meddling with details that the other subordinates are competent to cope with, and be always ready to learn tricks that the schools cannot be expected to teach.

At this point mention cannot well be omitted of a section of the local office force which does not strictly come under the head of the expert staff but is closely connected with it, to round out the sketch of organization; that is, the clerical equipment. At the smaller mines the superintendent and the assistant superintendent are able to handle a part at least of the work of this department; but with large operations that becomes impracticable. There may then be need at the mine as well as at the home office, of a local business staff, comprising a cashier or pay clerk, accountant, with time keepers and other clerks. Besides the book keeping and handling of money, considerable work is involved in preparing the mine reports and records. The systems of financial reports and book keeping have already been discussed in the

article by Mr. Charleton in the issue of this magazine for January, 1901, and also touched upon by the present writer in the January, 1903, number, so that there is nothing further to suggest now.

The surveyor should be not only an adept in accurate underground work but a good topographer and leveler for surface work, such as laying out roads, tramways, aerial ropeways, possibly railway branches, ditches, reservoirs, sites for buildings, and so on. He breaks in some of the hands about the mine as assistants in holding tape, setting plumb lights, targets, etc. With extensive workings it is necessary to keep up promptly with all advancing headings and see to it that the maps are brought up to date at short regular periods. Nothing need be said here as to instruments (which, by the way are steadily improving in portability and other respects) or as to the general system of notes and records, as all this is well understood by every mine surveyor; but it may be suggested that while a survey is being made the surveyor often has an excellent opportunity to observe features of the ground which should not be omitted from his notes and might be valuable guides in developing the mine. This does not demand any profound geological knowledge; common sense and experience go a long way, although a mine surveyor is naturally supposed to know something of field and economic geology.

Considerable trouble may be saved in short-distance work by simple compass-and-tape measurements, checking up from time to time with regular instrumental surveys. It is not indispensable to lug a transit into the mine every day or every week. On the other hand it is better that the surveyor himself should kep track of progress everywhere in the mine, not relying wholly on shift bosses—on contract work, for example—and see that back pegs do not become mysteriously automobile.

Not all surveyors fully appreciate the convenience of the graphic method, worked out on the drawing board with scale drawings and protractor, for laying off short connections, and thus dodging the trigonometry. The tendency, and rightly too, is for a careful surveyor to calculate everything with the closest exactitude after the most painstaking adjustments and checks of survey, and it is rank heresy to suggest anything else. Still—and the hint is thrown out for the benefit of superintendents who employ no regular surveyor—a great deal can be done in the way of short-cut wrinkles. There are occasions where the nicest refinements are essential and unavoidable, as in running long drainage adits, making connection with old workings, or meeting approaching headings, and amazingly close work has been

done in this line; but what applies to cases involving the hundreds and thousands of feet does not always hold with the fifties, seeing that a theoretical accuracy down to small fractions of an inch in a connection is wholly obscured by the inevitable roughness of the actual result.

There can hardly be too much detail in the large-scale maps of a big mine, not only for current uses, but to serve as records in case of shutting down, caving, and opening of new workings from which connections are to be run. If there are many surface improvements a cadastral map is needed, besides the plain topographical one. Boundaries and relations of contiguous mines, roads and railways, etc., should be clearly indicated. There should be a general underground plan (say 1 inch = 50 feet or less) showing all the different levels and inclines superposed. The working plan of each level should be on a very large scale, say even up to 1 inch = 10 feet, in separate sheets if necessary. The general longitudinal section along the strike may be either a vertical projection or made in the plane of the dip of the lode, and should show all shafts, inclines, winzes, location of cross cuts and trace of stopes (stoped ground on a flat or low-dip bed may also be shown in horizontal plan). Transverse sections are made along the plane of the principal cross cuts or cross-cut adit, or normal to the strike, and are of the same scale as the general horizontal plan and longitudinal section. Only two scales are needed for the working maps, and each set is correlated throughout as to scale.

All possible information as to important points developed in the workings should be indicated, known limits and courses of ore bodies platted, position of diamond-drill holes recorded, etc. Besides the regular draughtings, for reproduction in annual reports or prospectuses and for the information of the home office, still smaller-scale plans, sections, and maps, giving a general exhibit of the lay of the ground, showing the work done between certain dates, and omitting confusing details, may be found handy and useful.

The original plattings should be on mounted paper, preserved untouched as far as may be, and muslin tracings made from them. The originals have the distinguishing colors; the tracings to be used for making blue prints are of course in black-and-white only. Sets of blue prints are then made, and those sheets much referred to and handled should be backed. It is a convenience to avoid rolling, and cases of drawers should be provided to keep the sheets flat and clean, besides which wall copies may be hung for ready reference.

Arbitrary signs and colors may be used to give much information

at a glance and distinguish the workings and also geological formations. For the horizontal plans a color scheme may be adopted to distinguish ten to fifteen levels on one projection, and then repeated, for very deep mines. The colors used to indicate geological features should be plainly contrasting, rather than according to any of the standard color schemes of the books, in which related rocks or formations are represented by tints not sufficiently distinct in each group. Shafts, winzes, and inclines should have dimensions and number of compartments shown, upraises distinguished from sinkings, and surface mouths from blind connections. A complete legend should be added in a corner of each sheet, explaining signs, letters, and colors, perhaps giving other details. Mine surveys and maps are usually "magnetic"; if so, a correction for "true" is added, especially when the workings are expected to be occupied long in the future.

Some mines have enough work to keep a mechanical draughtsman busy, and at establishments having much plant with a machine shop and foundry annexed, a draughtsman who is also something of a designer is a useful man.

The assayer at a mine where there are no reduction works, or only simple plant such as a concentrating mill or a small gold mill, has a comparatively easy job and can arrange his work on a daily routine plan. In a well managed mine all the working faces are carefully sampled at regular intervals if there is any sign of ore, and in some formations not only the evidently very low-grade ore is sampled and assayed, but also the country rock itself, as offering a clue to direct the underground prospecting. This may call for considerable expertness on the part of the assayer in determining minute tenors of metal, involving the use of strictly chemically pure reagents and fluxes which he may find it expedient to prepare for himself, or at least to check with standards and blank assays; and to get weighable buttons or precipitates he may be compelled to combine many assays or rely upon optical measurements by the Plattner scale and microscope with micrometer stage, or similar refined methods.

The samples are variously taken according to approved methods underground, as by upper, middle, and lower cuts across the full width of the heading, or across (and at right angles to) particular seams; and it is usually the practice to have the breaking, mixing, and quartering down done at the assay office. There may also be special samples of specimen ore or of peculiar minerals. The assayer generally receives instructions from the superintendent or underground foreman, when the samples are delivered, as to the precise

object in view so that he may govern his procedure accordingly. The small samples after quartering down are best held in 4-pound or 6-pound canvas sample bags (scrupulously freed from former contents) with numbered tags, the numbers corresponding to memoranda as to nature and purpose of sample and exact locality from which derived.

It is expected that the assayer will be able to determine minerals by the eye and ordinary physical and blowpipe tests, and to distinguish the common rocks lithologically.

Besides the samples taken in the mine, run-of-mine samples are taken from ore cars, bins, or dumps, and of each shipment, for which purpose the common shovel method when loading or dumping suffices with most ores of fair uniformity and not too high grade, in which latter case greater care and perhaps running the whole lot through a sampling machine may be necessary. If there is a concentrator at the mine, the crude ore, the product at various stages of concentration, the tailings, and the slimes are, or ought to be, constantly sampled and assayed. Whenever possible and convenient it is best for the assayer to do his own rough sampling, and of course the final samples for assay and for an umpire assayer (in case of shipment and sale of ore) are prepared by him.

The selection of the site of the assay office is of some importance, means of delivering fuel and ore by gravity being worth having. The fittings of the office are suited to the kind of ore the mine produces, and should include a small rock breaker (run by wire-rope power transmission, if available), sampling apparatus capable of working down lots of considerable bulk, with the usual furnaces and apparatus and chemicals for wet analysis and color tests, as the case may require, scales and chemical balances, blowpipe kit, low-power microscope, testing outfit, etc. The assayer will need one or more helpers for firing and chores. If there is an extensive reduction plant operated in connection with the mine the assayer's duties become indefinitely enlarged and he may require a more elaborate equipment and several helpers, besides finding it convenient to locate his office at the metallurgical works.

System is maintained in the assay office by keeping regular records of all samples, tests, results, materials consumed, etc., with daily reports to the manager at stated hours. Blank printed forms and suitably ruled books save time and promote regularity.

So much electrical machinery and apparatus is in use nowadays that an electrician is often regularly employed at a large mine, with perhaps one or more helpers. In isolated localities a man is required

who is capable of installing plant, running it, and making repairs, so as to be independent of outside assistance. For a large plant the electrician should be more or less of an hydraulic engineer, steam engineer, and machinist; should understand the measurement of water and water power, the control of water supply, reservoirs, dams, ditches, flumes, pipes, etc.; turbines and impact wheels; steam engines, shafting, gearing, etc.; and all machines to be run by electric power. In his own particular field he has to install, manage, and repair the generators, wiring and supports, transformers, and motors of various kinds, surface and underground hoists, haulage, pumps, compressors, fans, drills, etc. Then if there is an electric-power installation there will be also the lighting to look after. Signalling by electric bells, and the telephone or telegraph may also come in.

There is usually one head underground foreman, aided by shift bosses; or there may be a day underground foreman and one for the night. The duties are supervisory in big mines (though he works with his hands in the smaller ones) and bring him into direct contact with all the underground force, for whose efficiency he is responsible. He is preferably a promoted miner of skill—steady, watchful, and reliable, for very much depends on him.

Large mines have also a day and a night surface foreman, who have in charge the general oversight of all surface plant and property and direct the surface labor. Other men of the skilled mechanic class, rather than the staff proper, are the head machinist and foundryman, head blacksmith, head carpenter and timberman, engineman, pumpman, ropeman, and their helpers; while underground are also station tenders, power-drill operators, and runners of various haulage, hoisting, and pumping machinery.

Thus far nothing has been said of that important man, the metallurgist, since his department is usually apart from the mine organization and may be an entirely independent establishment situated at some distance. With reduction works at the mine, the man directly in charge of them reports to the general manager or superintendent, and has his own staff of subordinates who are under his immediate orders. This introduces practically a new organism—an entity in itself, with its own specialists and labor force, too varied and intricate to be even briefly described in this limited space. The chief metallurgist, whether millman or smelter, must be a man of experience and thorough grounding if his field is at all a difficult one; it often happens that the success of the whole enterprise may depend even more upon his ability than upon the running and the productiveness of the mine

itself. He is generally a specialist, in the sense that he has given attention mainly or wholly to some one line.

To sum up, there may be at a great or even a fairly moderate sized mine, in addition to the "working force" of miners, carmen, stokers, common laborers, teamsters, etc., the following organization and staff (whether termed expert or not) all more or less indirectly effective in the management and output:—

The manager, agent, or superintendent (either in a single individual or two, with business and technical functions divided).
The assistant superintendent.
The clerical force and time keepers.
The surveyor and draughtsmen.
The assayer and assistants.
The electrician and helpers.
The underground foreman or foremen, with shift bosses, station tenders, timberman, pumpman, operators of underground machinery, blast firers, etc.
The surface foreman or foremen.
The head machinist and foundryman, the enginemen, etc.
The head blacksmith and helpers.
The head carpenter and helpers.
Other skilled mechanics.

And, if there is a reduction plant:—

The chief metallurgist (millman or smelter).
His immediate subordinates (in varying specialties and number, according to the kind of works).

Now all this means a considerable number of men having more or less official footing, none of whom actually produce (directly) a pound of ore or an ounce of metal—in addition to the large number of skilled and unskilled workmen who also are not engaged in the visible mining. How can this staff be simplified and reduced without injuriously affecting the purpose of the enterprise—the production and disposal of ore—so as to fit the managerial and auxiliary personnel to the needs and capacity of the mine? There are several considerations which will at once occur to the reader:

1. Elimination—that is, lopping off all functions which do not bear upon the particular case in point. Obviously, for instance, an hydraulic placer mine does not want an assayer, underground foreman, and most of the skilled mechanics; and after the ditch, flume, pipe, and sluice lines and cuts or tunnels have been laid out, the surveyor is

dispensed with. A large production might be had with a force consisting of a superintendent, one foreman, and a very moderate number of pipemen and laborers. A big stripping iron or manganese mine would want no surveyor after certain measurements had been made and tracks put in, and no assayer, for the samples would be sent elsewhere; so that the superintendent, clerks, foremen, and operators of the excavating and loading machinery would be about all the force except common labor required for a very heavy output. And so on with other classes of mines. The assistant superintendent might become a fifth wheel. In general, the number of foremen and clerks increases with the number of working hands, and the expert staff is cut down in proportion to the simplicity of the operations. If there is no reduction plant, that may eliminate about half the staff; if there is no machinery, then there is no need for an electrician, machinist, enginemen, etc.

2. Combination of functions in a single individual. A previous paper has shown how this is effected in the case of the superintendent. Then he may take charge of the business and clerical work or divide it with the assistant superintendent. The latter may do the surveying and draughting. The millman may be also the assayer—and so on.

3. Joint employment of individual specialists by two mines or a group of mines. This applies to nearly the whole staff, and is a frequent custom. It may reduce the number of berths open to newly graduated technical students and others; on the other hand it creates employment for a small number where otherwise there might be none. One ownership often operates adjoining or neighboring mines, when the plan is naturally resorted to and is carried out as far as warranted by circumstances; but two companies often combine in sinking and operating joint shafts or running joint drainage adits, and likewise have an assay office, mill, etc., in common, so that an arrangement for dividing the salary expense of several mine officers follows.

4. Reliance on outside assistance. In the older and more settled mining districts there are always one or more independent surveyors, usually an assay office, sometimes sampling works and testing laboratories, so that a mine which cannot afford or has not full-time work for expert help has a ready recourse. For special emergencies consulting engineers are called in to advise as to development of ground, selection of machinery, choice of metallurgical process, and difficult or unusual expert jobs. It is the small isolated mine which is at a disadvantage.

COST-FINDING METHODS FOR MODERATE-SIZED SHOPS.

By William Magrutor.

THE SYSTEM OF THE SOUTHERN ENGINE AND BOILER WORKS.

The series of articles of which this is the fourth began in December with an account of a system in use in a well-managed boiler shop. In January the example taken was a machine-tool works using the premium plan, and in February, a printing press factory in which stock-tracing was a peculiarly important feature. The purpose of every article is to furnish a working description of a practical system, in actual use in a shop where it has stood the test of time and proved sufficient, and with it to give fac-simile reproductions of all forms and blanks. This makes the papers particularly useful to those concerned with shop accounting.—THE EDITORS.

THE Southern Engine and Boiler Works, of Jackson, Tenn., manufacture Corliss and slide-valve engines, boilers, and saw-mill machinery, and employ about three hundred men. The business was organized about 1884, and re-organized in 1889. The present general manager, upon taking charge of the office, was quick to perceive the necessity of a system combining thoroughness with simplicity. The following system devised by the mechanical engineer of the company and put into effect by him has proven highly satisfactory, no changes having been made since its installation. In this method all records are kept on cards adapted to index filing, no books being necessary. This method saves labor of transcription; the record is more readily accessible, with vastly less labor and no delays caused by posting, while the similarity of orders makes it extremely simple, and the uniformity of cards, there being but two sizes, has rendered the filing of records both easy and convenient.

The general manager has absolute control, and the factory is divided into two departments—Production Department and Business or Accounting Department; the production department is subdivided as follows: drawing room, pattern shop, foundry, machine shop, blacksmith shop, saw-mill department and boiler shop.

The shop neither builds nor repairs any machinery except by written order from the general manager. In issuing an order for a machine, the general manager fills out two General Order cards No. 1; he retains one at his desk and sends the other to the superintendent, who place it on temporary file, and issues Production Order No. 2, to the different foremen. If, however, the order is for a new machine,

GENERAL ORDER No. _____

Contact No. | Symbol | Date 190

Ship to _____

Via ___ Express ___ Freight ___ Open ___ Shippers Order _____

Bill to _____

Complete order on or before _____ 190 Checked by _____

Date shipped 190 | Shipping Clerk

DESCRIPTION

SOUTHERN ENGINE & BOILER WORKS _____ Gen. Mgr. | Punch

FORM 1. GENERAL ORDER. 6 BY 4 INCHES, BLUE CARD.

or embraces any change from the standard, the superintendent sends the general order to the draughting room to have necessary drawings attached and returned to the superintendent, who disposes of them as above stated. The superintendent and foremen through whose hands the different orders pass do not sign their names, but use a conductor's punch, each cutting a different shaped hole in a square on the card indicated for this purpose. This is true of all orders; they are

PRODUCTION ORDER NO. _____

Date 190

Foreman _____ Please execute the following order and charge all labor and material to the above number.

Above order to be completed on or before _____ 190 _ | Punch

SOUTHERN ENGINE & BOILER WORKS, _____ Supt.

FORM 2. PRODUCTION ORDER. 5 BY 3 INCHES, BLUE PAPER.

MATERIAL REQUISITION

Order No. _____ Date _____ 190

QUANTITY	ARTICLE	COST	

Southern Engine & Boiler Works _____ Foreman Punch

FORM 3. MATERIAL REQUISITION. 5 BY 3 INCHES, YELLOW PAPER.

signed by the proper person issuing them, and all others through whose hands they pass use punches. This enables every action which has been taken on an order to be recorded without covering it with notes and signatures. The production cards, issued by the superintendent to each foreman, bear the same number as the general order, and are issued in duplicate. These are in book form, gummed together at the end, so as to be readily detached. One is retained by the superintendent, who places it on temporary file with the general order of the same number. The other copy is sent to the foreman, who makes

Date 190__ SPECIAL MATERIAL ORDER No. _____

Required for _____

Please order the following to be received by _____ 190__

SOUTHERN ENGINE & BOILER WORKS _____ Punch

FORM 4. SPECIAL MATERIAL ORDER. 5 BY 3 INCHES.

out Material Requisition, No. 3, numbers it the same as the production order, and sends it to the store keeper who fills out an order and returns the original order to the foreman with the material, entering the cost of material, or fittings, in the cost column, using for that purpose a cost mark which is understood by the cost clerk, the superintendent, and himself. The foreman attaches the material requisition to his production order.

SOUTHERN ENGINE AND BOILER WORKS.
JACKSON, TENN.

To_____ Date _____ 190_

Order No. _____

Please Ship the following goods by _____

Ship Via. _____ Terms _____ To be received on or before _____ 190_

In refering to this order, use number, and put same on bill, this will facilitate payment.
Send bill in duplicate.

SOUTHERN ENGINE & BOILER WORKS,

Gen. Mgr.

FORM 5. PURCHASING CARD OR SHEET.

Reproduction shows heading and footing only. The original is 6 by 10 inches, white paper.

If special material has to be ordered for the job, the superintendent fills out Special Material Order, No. 4, numbering it the same as the general order, and making stub entry, and sends it to the general manager, who fills out the Purchasing Card, or a sheet, No. 5, making a stub entry or a duplicate. He then returns the special material order, No. 4, to the superintendent, who is thus informed that the material has been ordered, and he will know when it is to be received. The superintendent files his special material order with his general order.

Upon receipt of the bill for special material, which is usually in duplicate, one copy is handed to the superintendent, who files it with the original special material order, No. 4. If, however, the material bills are not issued in duplicate, the manager marks "Return" across the face of the bill, and sends it to the cost clerk, who makes the proper entries on the special material order which the superintendent has on temporary file, and returns the bill to the general manager.

When the foreman receives the necessary material on a production order, No. 2, he assigns the job to one or more of his men, and makes

TIME CARD

Order No. Date 190

Symbol	Machine
Kind of Work	Part
Workman's No.	Workman's Name

7 | 8 | 9 | 10 | 11 — Regular

1 | 2 | 3 | 4 | 5 — Overtime / Total

NOTICE TO FOREMAN — Give workman the following orders:

1 Count pieces before beginning work.
2 Report to Foreman 15 minutes before completing work.
3 Notify Foreman of the exact time work is completed.

The above work has been inspected and approved _____ Foreman

FORM 6. TIME CARD. 5 BY 3 INCHES, PINK CARD.

a cross on Daily Time Card, No. 6, showing the time the workman begins. When the work is completed, he crosses the time of completion; the card is issued at the beginning of each job, or day. The time card bears the same number as the production order. At the completion of the order, he attaches the workman's daily time card and the material requisition, No. 3, to the production order, and returns the cards to the superintendent, who files them with the general order until it is completed—that is to say, until each foreman has completed his part, and made his report as above. This includes testing, painting, and crating. Then the superintendent attaches the production order to the material requisition, and the workmen's daily time cards of the several foremen to his original general order, and hands the whole file to the cost clerk, who makes the proper entry on an Individual Cost Card, and also on the Comparative Cost Card, No. 7. These individual cost cards are filed in numerical order, and show the total cost and the cost of each factor entering into the construction of that machine. comparative cost cards, No. 7, are provided, one for each line of standard machinery—that is, one for each size of machine. These cards show the comparative cost of all these machines, and are in duplicate, one set being in possession of the superintendent, and the other in possession of the general manager. At the completion of each machine the cost clerk makes proper entry on both the superintendent's and manager's cards. This comparative cost card enables the manager to see what each machine has cost, and also to check any irregularity in the production. It also serves the general manager as a stock list, as he

can see how many completed machines he has in stock at any time, it being remembered that the cost clerk makes these entries as soon as the machine is completed. This gives the general manager the exact cost of the machine, and informs him that the order is in the hands of the shipping clerk. The manager can see by referring to his general orders, No. 1, on temporary file, the number of machines in stock, the number of machines in course of construction, when they are to be completed, how many of these have been sold, and how many are for stock.

The general order which was received from the superintendent, the cost clerk gives to the shipping clerk—that is, if the machine has been sold; otherwise, the general order is handed direct to the general manager. The shipping clerk after executing his part of the order and making the proper entries, returns the order to the general manager. His entry upon the general order informs the manager of the completion of the order. The manager files the general order returned to him numerically; the one he has on temporary file is filed alphabetically. Thus the two original general orders are filed in such a way that they may be found at once from the number of the order, or the name of the purchaser. It is understood that the machine always bears the same number as the order.

All orders for repair work come from the manager's desk. He fills out Repair Order, No. 8, in duplicate, retains one on temporary

COMPARATIVE COST CARD

Machine _____ Symbol _____

Total Wt. of Material	Total Value of Material	No. Hrs. of Labor	Total Cost of Labor	Shop Exp. Add-%	Aggregate Cost	Order No.	SOLD TO	Date Shipped

FORM 7. COMPARATIVE COST CARD. 6 BY 4 INCHES, YELLOW CARD.

file, and sends the other to the superintendent. The superintendent fills out the production order, No. 2, as in the case of a general order, with the exception that the number of the order is preceded by the letter "R." This he sends to the foreman, or foremen, who execute it in precisely the same manner as the general order. When the work is completed, the foremen attach their daily time cards and material requisitions to their production order, and return the file to the superintendent, who attaches the original repair order and forwards all to the cost clerk. He fills out both repair order cards—that is, the one that has been handed him by the superintendent, and the one that has been retained by the general manager. He then hands the one he has received from the superintendent to the shipping clerk. When shipment has been made, the shipping clerk makes the proper entries on the

Date 190 REPAIR ORDER No. _____

For _____ Ship to _____

Via _____ Bill to _____ Ship _____ 190 ____

Date shipped 190 Shipping Clerk. Checked by

Please execute the following order and charge all labor and material to the above order.

Cost of Drawings	Cost of Patterns	Cost of Material	Cost of Labor	Cost of Sundries

Prime Cost _____ Shop Expense Add ___ % Total Cost _____

Contract Price for the above $ Profit $

SOUTHERN ENGINE & BOILER WORKS _____ Gen. Mgr. | Punch

FORM 8. REPAIR ORDER. 6 BY 4 INCHES, BUFF CARD.

repair order, and returns it to the general manager, who files one in numerical, and the other in alphabetical order. The cost clerk then sends the daily time cards, which were attached to the order, to the time keeper, and the requisition orders to the store keeper.

It is the duty of the superintendent to issue lot orders for all lots of standard parts of standard machines. This he does by issuing Lot Order, No. 9, in duplicate. One of these he sends to the foreman of the department in which the work is to be executed, and the duplicate he retains on temporary file. The foreman handles this order precisely as he would a production order; that is, he issues the necessary requisition orders, No. 3, and when the lot is completed, attaches

LOT ORDER No. _____

Symbol _____ Date _____ 190

Foreman _____ Please execute the following order and charge all labor and material to the above number.

No. of Pieces in Lot	No. of Drawing
Description	

SOUTHERN ENGINE & BOILER WORKS, _____ Supt.

FORM NO. 9. LOT ORDER. 5 BY 3 INCHES, BUFF COLOR, THIN PAPER.

material requisitions and daily time card, No. 6, to the lot order, and returns them with the completed lot, to the superintendent, who inspects the work and forwards the completed lot to the stock keeper, who again checks the work and places the pieces in their bin. The superintendent hands the lot order, with time cards and requisitions, to the cost clerk, who fills out a Lot Cost Card, No. 10, and Comparative Lot Cost Card, No. 11, for the superintendent, who has ready for reference the cost of labor and material entering into each lot;

LOT COST CARD

Lot Order No. _____ Date _____ 190

Symbol _____ Part _____ No. of Pieces in Lot _____

LABOR	No. of Workman Use No. instead of Name	No. of Hours	Cost of Labor	MATERIAL	Weight	Cost
Assembling				Babbitt Genuine		
Babbitting				Babbitt Common		
Blacksmithing				Brass Cast		
Boring				Brass Rolled		
Chipping				Iron Cast		
Drilling				Iron Wrought		
Erecting				Steel Sheet		
Filing				Steel Soft		
Grinding				Steel Tool		
Key Seating				Piping		
Milling				Lumber		
Painting				Incidentals		
Planing				Cost of Material		
Polishing				Cost of Labor		
Sloting				Prime Cost		
Tapp'g & Thread'g						
Turning						
Testing						
	Total					

FORM 10. LOT COST CARD. 6 BY 4 INCHES, WHITE.

COMPARATIVE LOT COST CARD

Symbol

DATE	No. of Lot	No. of Pcs. in Lot	No. of Draw'g	Wt. of Material	Cost of Material		Workman or Workmen. Use No. instead of Name	Hrs.	Cost		Prime Cost of Machine	

FORM 11. COMPARATIVE LOT COST CARD. 6 BY 4 INCHES, WHITE.

any variation in cost of production is at once noted and investigated. The cost clerk sends the daily time cards, which accompany the lot orders, to the time keeper for checking the time register, as above stated. All requisitions are returned to the store keeper, who files them in proper order. The cost keeper also places the average cost per piece of each lot over their respective bins, using a cost mark for this purpose.

In the above system the following conditions necessary for a precise, simple, and effective system have been fully met:

First.—All business entering and leaving the shop passes through the hands of the general manager.

Second.—There is a check upon every man in the shop, and upon every man in the accounting department.

Third.—Every man's duty has been clearly defined, and the responsibility for each movement, or operation, has been placed upon one man only. There can be no shifting of the responsibility for the delay or error in executing an order.

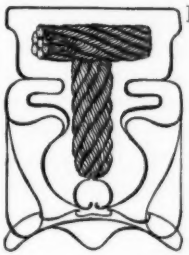
The perfect simplicity of the system, so far as pertains to the heads of the different mechanical departments, is evidenced by the fact that the several foremen are in possession of but two cards—*i. e.*, they issue but two—material requisition, No. 3, and daily time card, No. 6, and these are used in precisely the same way in executing any order they may receive; that is, the three orders—production, lot, and repair orders—are executed and disposed of in precisely the same manner by the foremen. The foremen have no permanent records to keep.

FOUNDRY MANAGEMENT IN THE NEW CENTURY.

By Robert Buchanan.

IV.—SPECIFICATION AND PURCHASE OF COKE, IRON, AND SAND.

Mr. Buchanan's first article appeared in our issue for December and dealt with the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant. His second paper discussed crane service for the foundry floor; his third, moulding by hand and by machine. The next will take up the management of the cupola.—THE EDITORS.



THE purchase of materials to best advantage for use in the foundry demands special knowledge in the buyer which is sometimes, but not always, present. When a trained foundryman is in full control of the foundry, purchasing as well as manufacturing, special knowledge of foundry requirements is always present; but he may lack the special acumen and knowledge of markets possessed by a professional "buyer" devoting his whole time to the business of buying.

Where a buyer devotes his whole attention to buying, and the materials bought are subject to the approval or disapproval of the one who is responsible for the working up of the raw materials into the saleable casting, there probably is found the best combination of qualities by which good and economical buying may be effected. The buyer seeks for low prices, and if unchecked is apt to make the invoiced prices of materials the only thing worth considering. The user of the materials has to see that the low prices of the buyer do not run up his costs in other directions and so prove to be a delusive gain. On the other hand, if the user of the materials asks for higher priced goods he should be called upon to give reasons for his demand. A prejudice is not enough. An objection to certain goods, if well founded, will in the very great number of cases be demonstrable by reference to facts and figures cropping up somewhere in the course of manufacture. The system to which I have referred forms a very effectual barrier to either buyer or user serving personal ends by purchasing or recommending goods of low value at a high price.

The businesses which are large enough to employ a buyer who does nothing else are, however, comparatively few in number compared with those where buying is only a part of the duties of the employer,

foundry manager, or other responsible person. Whoever he be, it is desirable that such considerations shall prevail and such tests be made as shall take the purchase of materials away from the influences of prejudice into the cooler atmosphere of reason and of fact.

Purchase of Pig Iron.—The branding of pig irons with names, usually those of the district in which the blast furnaces were situated, was and is useful, inasmuch as it forms a means of readily ascertaining the furnaces from which each make of iron comes. By-and-bye the brand was taken to indicate more than the furnace or district of origin. It came to be considered as conveying an idea of certain qualities as belonging to irons of the particular brand. That these irons did have these particular qualities in some measure there is no reason to doubt. The extent of the variation of quality was not readily determined, but that such variation existed there is also no doubt. Most foundrymen are bondsmen to certain brands of iron because they know that with these irons they may look for certain qualities with a fair amount of certitude. From these brands they do not dare to stir. It is high time that foundrymen tore themselves away from the idea that quality of iron arises from anything beyond what is produced by the fuel used, the method of smelting employed, the ores smelted, and the resulting constituents in the pig iron so made.

To the founder the methods used in smelting and the ores charged into the blast furnace are of only slight interest, but the constitution of the resultant iron is to him of the first importance.

When the seller of pig iron produces a small piece, the newly fractured face coruscating with beautiful large crystals of iron, he is apt to look glum when told it is largely a matter of slow cooling and indicates little of what the iron really is. We smile at the idea of the man who shewed a brick as indicating in some degree the kind of house he had to sell. The man who goes about with a piece of pig iron has more reason for his proceeding, as people take him seriously and buy the pig iron. In saying so it is not desired to minimise the information which fracture gives regarding the quality of iron. Fracture does in some measure indicate quality. Hematites, grey foundry iron, mottled iron, white iron, can each and all be identified by fracture; but the causes which produce the particular appearances are inherent in the constituents common to all, but varying in quantity and arrangement. So is it that we require something which shall tell us the amount of the various constituents present with some degree of exactitude. Thus we may use irons of varying characteristics, blending them into one of fairly definite quality. Chemical analysis is of course

the means to adopt for a more thorough knowledge of pig iron, and becomes an important aid to a true judgment of the value of the particular iron under review and possibly to be purchased. It is really an added sense of perception.

People selling pig iron as a rule prefer selling by fracture, and some of the salesmen have the haziest notion of what their iron really is. This explains the calmness with which sometimes they quote prices for ordinary pig irons which would be reasonable were hematites under consideration. With analysis as a guide every pig iron may be properly classified as to value. Often special lots may be bought favourably, owing to some occurrence at the blast purchase causing the iron to be "silky" or siliceous. How to use these irons advantageously, and also the effect of silicon and the other constituents present in pig iron, will be considered in treating of the cupola.

In British pig irons the percentage of phosphorus has the closest possible relation to price. A high price may be paid for irons high in phosphorus as a result of bad buying, but irons low in phosphorus cannot be bought cheaply. This is due to the high cost of hematite ores, the scarcity of which, from present appearances, is likely to make irons low in phosphorus gradually increase in value. Careful observation shews that with good buying, taking say 1.2 per cent. of phosphorus as a starting point, and using analysis as a guide, every lessening of the percentage of phosphorus by about one-third of one per cent. costs over two shillings more per ton of pig iron purchased.

Sulphur should not be over 0.05 per cent. Manganese up to 2 per cent. is permissible, but such an amount is too high unless at the same time other irons are used which are low in manganese. For soft castings total carbon should be the highest obtainable. It is seldom over 4 per cent. Silicon may vary from 1.5 to 3 per cent., the former for heavy castings, the latter for light castings.

When the pig iron maker or merchant offers pig iron for sale, he should be made to quote analysis as being quite as important as price. If both be suitable and purchase be agreed to, the purchaser should see when deliveries are made that the quality is as promised. This he can do by taking borings from the fractured surface of six pigs taken from different parts of the consignment. If an agreement be made with a metallurgical chemist the cost of the necessary analysis is small compared to the advantages secured. It will probably be found best to arrange for a certain number of analyses to be made in the course of six months or a year. The number will depend upon the size of the business and the thoroughness with which the system is employed.

Sand Allowance.—This is an allowance which pig-iron makers in many cases are very loth to recognise, but which may legitimately and fairly be insisted upon by the foundrymen. That much sand adheres to the pigs every one is aware. If pig iron is delivered per net ton of 2240 pounds, then the founder is not getting what he bought. He wants iron and iron only, if the pig-iron people would be so good as give him that. Makers of pig iron find it best for them to run the pigs onto sand beds. Until the machine-casting of pig iron is perfected and purchase by fracture has been superseded, they are likely to continue doing so. The foundryman wants iron, not iron and sand. Yes, the sand helps to flux the cupola; but when the foundryman is face to face with the difficulty of fluxing the cupola, he will manage sand enough for fluxing purposes at something under sixty or more shillings per ton. Often the foundryman is soothed by a single pig being added on top of the net weight in the railway wagon, but six tons of pig iron carry more than one hundredweight of sand on them. Some firms who recognise "sand allowance," give it to the extent of 28 pounds per ton of pig iron. Others have a "sand allowance" column in their "delivery notes," giving 1½ per cent., and foundrymen should insist on this allowance being more generally recognised and given. Seeing that in a purchase of 100 tons of pig iron the sand allowance equals 25 hundredweight, if 28 pounds per ton be allowed, the consideration of getting or not getting it ought to have a very great influence in deciding which iron to purchase, other things being equal. If sand allowance be not received, the manager or superintendent of the foundry is certain to be short in his stock of pig iron. Such shortage is usually accounted for by putting it down to excessive loss in melting. No one can make castings from sand, nor from the mixture of sand and iron which forms the skin of pig iron. These form slag and slag only. The legitimate loss in melting is and ought to be quite outside the loss due to sand on, or combined with, pig iron.

Accurate weighing of the pig iron as it enters the works, and accurate taring out of the wagon or truck, is the only way to assurance that the sand allowance is being received. It is not enough that it appears on the delivery notes.

Purchase of Scrap Iron.—Many firms engaged in making light castings do not buy scrap. Their own foundry scrap is sufficient for their purpose. Most foundries making heavy castings buy in scrap, often using considerable proportions in the cupola charges.

In buying heavy scrap one has to consider the breaking up into handy pieces for the cupola. Some recognise a relation of value

between pig and heavy scrap iron as being equal to a difference of 5 or 6 shillings per ton. This is not enough. Scrap iron is often rusty and dirty, takes more breaking and handling than pig iron, has a less definite composition, and is subject to more wasting in the cupola. Burnt iron is dear at almost any money and is fit for only the very commonest and cheapest castings. The oxide on burnt iron readily combines with the lining of the cupola, forming a very fusible slag. So where burnt iron is used there is found a great wastage of iron, a great wastage of the cupola lining, copious slag, and weak castings having excessive shrinkage. The excessive shrinkage is due to the low total carbon, which in one sample of burnt iron was only 1.143 per cent. Heavy machinery scrap is much sought after. It has the advantage of having less rust and dirt about it for the weight of iron bought than medium or light scrap has. Many foundrymen deceive themselves as to the virtues of heavy scrap, and have the idea that when mixed with pig iron it produces softer castings than light scrap will in similar conditions. Some heavy scrap may do so, but the greater part will not. A comparison of the silicon contents of both will shew this. Heavy scrap has seldom over 2 per cent. of silicon; medium and light scrap seldom have so little as 2 per cent., and it often goes up to 2.75 per cent. As silicon is a softening agent the point is obvious. Light scrap has the highest phosphorus, sometimes as much as 1.6 per cent., and not often under .90 per cent. in miscellaneous medium and light scrap. Sulphur in scrap of any kind is very seldom under .09 per cent. and a safe average to calculate on is .11 per cent. The kind of scrap to buy will depend on:

(1) The quality available.

(2) The class of castings manufactured.

(3) The pig irons available to counterbalance the particular defects of the scrap.

(4) The skill with which the defects in opposite directions of scrap and pig iron are made to neutralise each other, and so form a suitable mixture.

Purchase of Coke.—The qualities required in foundry coke are a high percentage of carbon, low percentage of sulphur and ash, and considerable density of structure; that is, it should be a heavy coke. Coke having 90 per cent. carbon is satisfactory so far as carbon is concerned. Carbon of 91 per cent. may occasionally be met with; 92 per cent. is rarely obtained. For foundry purposes coke having carbon under 86.5 per cent. should not be purchased. The shortage in carbon is made up by an increase of ash, or worse still, of sulphur. When

using coke low in carbon an increased quantity is required. The increased ash requires more fluxing; the increased fluxes require to be melted, and so the waste goes on. High-carbon coke is the cheapest in the end, and it is the business of the foundry manager or foreman to prove it so by practical results.

Ash in foundry coke ranges from between 6 and 7 per cent. to over 10 per cent. As already stated, ash usually takes the place of carbon, when the latter is deficient. The difference between a coke of 6.52 per cent. ash and one of 10.30 per cent. is over 84 pounds of ash per ton of coke. When it is considered that that 84 pounds should be carbon which will do melting, instead of ash which itself has to be fluxed and melted, it is easy to see that the coke with 10.30 per cent. ash at one shilling per ton less in price than the other is a bad bargain.

Sulphur in foundry coke ranges from 0.53 per cent. to over 1 per cent., and the average is a little over 0.75 per cent. in good coke. Sulphur should be jealously watched, its hardening effect upon the castings is so great.

When purchases of coke have to be made, the makers or merchants should be asked to quote on a basis of supplies not falling under or over the following percentages:

Carbon not to be under 88 per cent.

Ash not to be over 8 per cent.

Sulphur not to be over 0.75 per cent.

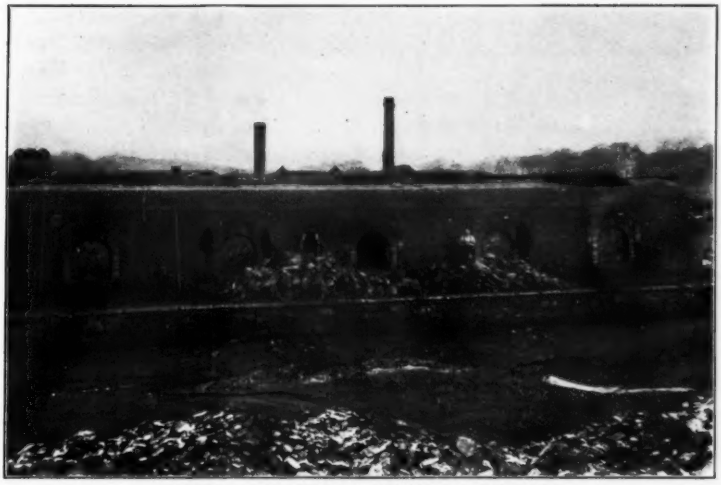
Coke having carbon under 86.5 per cent. is to be rejected. As coke is carried in open trucks, and so is subject to the rainfall during transit from the coke-ovens to the foundry, excess moisture is difficult to guard against. In summer the moisture should be under 1 per cent.; in winter it will readily be over 3 per cent. After a night's rain it has been observed that the coke on the top of a truck contained as much as 7½ per cent. of water. The lighter the coke the more water it will take up, as might be expected.

(a) One cubic inch light coke which weighed dry 172.25 grains, when saturated gained 7.9 per cent. of water.

(b) One cubic inch heavier coke which weighed dry 213.50 grains, when saturated gained 6.6 per cent. of water.

(c) One cubic inch heavy coke which weighed dry 298.50 grains, when saturated gained 2.3 per cent. of water.

The density and hardness of coke are very important. A dense or heavy coke has the particles closely and firmly adhering together and so it stands without decrepitation the impact of the falling iron charged into the cupola. It must also sustain the weight of the



BEEHIVE COKE OVENS, ACCRINGHAM, ENGLAND.

charges of iron, and withstand the action of the blast, while in an incandescent state of heat, until dissolution takes place by the combustion of the carbon. Foundrymen can usually tell very nearly the quantity and density and hardness of coke by simply handling it, but they must rely upon the chemist for exact percentages of carbon, ash, and sulphur. The knowledge that exact methods for ascertaining the constitution of the coke are employed goes a great way in obtaining the quality desired. Merchants endeavour to supply what is required, and let the lower qualities go to users not in a position to test supplies except by using them. In the latter case no one can readily decide whether it is the coke or the mode of using it which is at fault.

A simple test for density may be made if one has a laboratory scale as illustrated on page 886. Take a small piece of the coke to be tested, grind it on the emery or other abrasive wheel to a one-inch cube. Thoroughly dry it at a temperature not exceeding that of boiling water; then weigh. A cubic inch of coke of fair density weighs 230 to 240 grains when free from moisture. This test for density is a very simple one, puts on a proper basis which has hitherto been merely an assertion, on one side or the other, and is dependent on no previous scientific training or experience. A rough test for density may be made by dropping a piece of coke into water. If it floats it weighs less than 253 grains per cubic inch. If it sinks it weighs more than 253 grains per cubic inch.

A FOUNDRY LABORATORY SCALE.

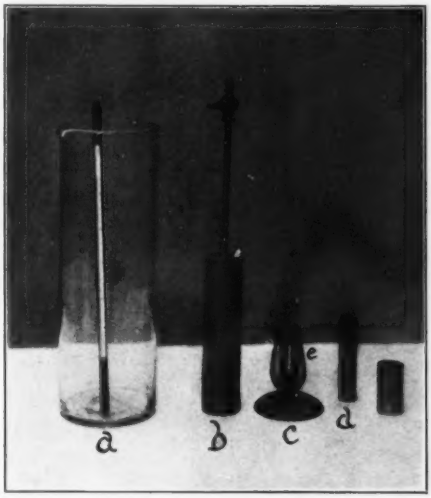
In the United States coke is designated "72-hour coke" or "48-hour coke," the terms indicating the time the coal is undergoing the coking process, and being used to express quality. These terms are not used in Great Britain. The only reliable tests for quality are chemical and physical tests, supplemented by the test of amount of iron melted per pound of coke used. Here the personal element comes in, but it is not likely to cause trouble if once it is clearly understood at the cupola that the one at the head of affairs has an accurate knowledge of the quality and condition of the coke. Indeed, good results are more likely to be obtained, as carelessness, neglect, or waste can be located at once and the cupola man knows it.

Fluxes.—Every foundry requires fluxes for use in cupola melting, unless the melt be of a very modest character indeed. Even then it will be more profitable to use a flux. When a flux is not present iron has a most unhappy way of taking its place in the slag. Limestone is the flux which is in almost universal use. In a few places, owing to local conditions, oyster shells, chalk, or marble chippings may be used, but in every case it is the basic quality of lime which is utilised. Fluorspar is sometimes used as a flux either by itself or in conjunction with limestone. Limestone only will be considered now, and fluor spar when the cupola comes under review. Limestone should have the greatest amount of calcium carbonate obtainable. In limestone of good quality this will amount to about 98 per cent., the remaining 2 per cent. being small percentages of magnesia, alumina, silica, etc. Should silica be present in any appreciable degree, and it sometimes reaches over 4 per cent., the quality is depreciated accordingly. The silica present in the limestone takes up just as much of the calcium

carbonate as will flux it, and so there is a double loss, and the slag is also increased in quantity. It will be found in most cases advantageous to buy limestone broken ready for use. This costs very much less in the end than buying limestone lumps. These take a deal of breaking by hand, and they are not broken so small as is done by the stone-breaking machine. The smaller the pieces of limestone the more suitable they are for cupola use, so that they be just large enough not to be blown away by the blast.

Purchases of Refractory Materials.—These include fire-clay, fire-bricks and ganister. Fire-clay is usually described as being a hydrated silicate of alumina, that is, it is a compound of silica and alumina with some water in the combined form. Any other bodies present in addition to those act as impurities and so lower the point of temperature at which fusion takes place. This is especially true of soda or potash, and in a less degree, of oxide of iron and lime. The greater the proportion of alumina the less fusible fire-clay is and the less subject to the cutting action of slag. Fire-clay is plastic in proportion to the fineness of the particles and percentage of alumina. The principal objection to fire-clay is the great shrinkage which takes place while passing from the plastic to the burnt condition.

Where analysis is inconvenient or not available, a simple test for fusibility may be made if one has a pot furnace such as brass founders use. Form a portion of the clay into a small pyramid having sharp angles and apex. Dry the pyramid with a gentle heat, then place it in a small crucible, lute on the lid with a little fire-clay of known good quality, and subject the crucible to a good strong heat for an hour or more in the pot furnace. If only of fair quality the pyramid will show signs of fusion. If of bad quality, instead of a pyramid the clay will be a formless mass.



THE CALORIMETER AND ITS PARTS. SEE PAGE 890.

The following analysis from Greenwood's "Steel and Iron" may be taken as an example of good fire-clay:

STOURBRIDGE FIRE-CLAY.

	Per cent.
Silica	63.30
Alumina	23.30
Potash	—
Soda	—
Lime	.73
Magnesia	—
Ferrous Oxide	1.80
Water combined, " Hygroscopic, Organic Matter	10.30
	99.43

Ganister.—Ganister is a refractory material much used for "fettling" and repairing cupola linings. It is composed principally of silica with a small percentage of alumina as the binding material. It is less plastic than fire-clay but does not crack so readily when heated. Like fire-clay it should be free as possible of soda, potash, lime, and oxide of iron. A test for fusibility may be made exactly as for fire-clay. Analyses of three samples are given on the opposite page.

No. 1 was the best of the three in actual work. No. 2, notwithstanding its purity and high percentage of silica, was the least satis-

SIMON-CARVE COKE OVENS, ALTHAM COLLIERY CO., ACCRINGHAM, ENGLAND.

factory, wasting and forming most copious slag. This shews that however satisfactory such a material would be in a position away from the action of basic slags and oxide of iron, ganister with silica over 94 per cent. is useless at the melting zone of a cupola. What it wants is a greater percentage of alumina.

ANALYSES OF GANISTER.

	(1) Welsh Ganister. Per cent.	(2) Welsh Ganister. Per cent.	(3) Sheffield Ganister. Per cent.
Silica	84.54	94.70	86.48
Alumina	7.78	4.27	4.57
Oxide of Iron	4.85	0.78	3.43
Lime	0.13	Trace	Trace
Magnesia	—	Trace	—
Loss on calcination	2.68	—	5.46
	99.98	99.75	99.94

Fire-Bricks.—These have as a first necessity the quality of not softening at a high temperature. In the second place they must not disintegrate or chip under the influence of heat, and they should not be readily fluxed by the slags running down them. Excessive expansion and contraction are causes of objection as likely to cause a shorter life to the cupola or furnace lining, and fire-bricks for cupola use should be able to withstand quick changes of temperature from the highest melting temperature to the normal temperature of the atmosphere without excessive cracking. That fire-bricks combining these qualities to a very satisfactory degree are available says much for the excellent materials used and mode of manufacture employed.

The following analysis is that of fire-bricks noted for their non-expansion under high temperatures, as well as for the usual qualities to be found in fire-bricks of high quality.

	Per cent.
Silica	62.10
Alumina	33.10
Ferric Oxide	3.00
Lime	0.90
Magnesia	trace
Potash	0.90
	100.00

Purchase of Coal.—The quality of coal which is bought for firing boilers or for the stoves or ovens in which moulds and cores are dried depends upon the carbon present and also upon what is termed "the available hydrogen." All coals contain oxygen and hydrogen, and when combustion takes place these two elements combine in the proportion of two atoms of hydrogen to one of oxygen and so form water

vapour. When the oxygen present in the coal has all been so combined, the hydrogen which is in excess is of high calorific value and being burnable is called "the available hydrogen" as stated. Thus if two coals have equal percentages of carbon the one with the most "available hydrogen" will be the better of the two.

The calorific intensity or heat-giving quality of coal may be ascertained and measured by means other than the quantitative analysis of the constituents. By means of the "calorimeter" the total heating effect of carbon and hydrogen present may be measured rapidly and accurately. Fortunately the "calorimeter" is simple to use even by those having no training in the use of scientific instruments.

The following description and method of using the calorimeter is from Hiorns' "Practical Metallurgy and Assaying." The apparatus consists of a tall glass cylindrical vessel (a) capable of holding 60,000 grains of water. (The vessel shown on page 887 contains about 40,000 grains.) At a given height a mark is scratched on the outside to indicate 29,010 grains of water, which equals 967 × 30 (the former figure being the latent heat of steam, and the latter the weight of fuel taken). A copper vessel (b) is fitted at the top with a stop cock; and a perforated stand (c) into the socket of which the copper crucible (d) fits. The stand has four springs (e) for keeping the cylinder (b) tightly fixed to the stand.

"To determine the calorific power of a given fuel, carefully dry a quantity of finely powdered potassium chlorate, and nitrate, in separate dishes. Also a quantity of the fuel very finely powdered should be dried for half-an-hour at least in a water oven. (Note. It may be dried anywhere so that the temperature does not exceed that of boiling water.)

"Weigh out 30 grains of the dried coal, 225 grains of potassium chlorate, and 75 grains of nitre, mix well and introduce into the perfectly dry copper tube of what is known as Thompson's or Wright's calorimeter. Ram it moderately tight, insert a small piece of fuse (prepared by soaking cotton wick in a solution of nitre and drying it) and place the tube in the stand ready for the experiment. Now take the temperature of the water in the large vessel; light the fuse; cover with the bell tube (b) taking care that the tap is closed, and put the whole in the water before the ignited fuse has had time to burn down to the mixture. When the combustion appears complete, open the tap so that the water may absorb the residual heat in the tube; and again take the temperature of the water. The increase of temperature plus 10 per cent. added for loss gives the evaporative power of the fuel.

EXAMPLE.

Temperature of water before the experiment.....	55°F.
Temperature of water after the experiment.....	66°F.
Temperature produced by the combustion.....	11°
Plus 10 per cent.	1.1°
Total evaporative effect	12.1°

i. e., 1 pound of the coal on perfect combustion will generate 12.1 pounds of steam.

"The calorific value of fuel may be estimated in "calories" or in vapour units. The calorie represents the heat absorbed by the unit

weight of water when its temperature is raised one thermometric degree, the centigrade scale being most generally employed. The vapour unit was proposed by Rankine and corresponds to 537 calories if the centigrade scale be used, and 967 calories for the Fahrenheit scale. In order to express calories in vapour divide by 537 or 967 respectively. To convert vapour units into calories multiply by these numbers. Take the example given, viz., 12.1 vapour units; $12.1 \times 967 = 11{,}700.7$ calories."

To prevent misapprehension it may be stated that the potassium chlorate and the nitre do not themselves provide any heat; they merely supply oxygen for the combusion of the fuel while the latter is cut off from the oxygen of the air. The crucible (d) is used for long-flaming coal containing hydrocarbons, the shorter crucible is used for anthracite.

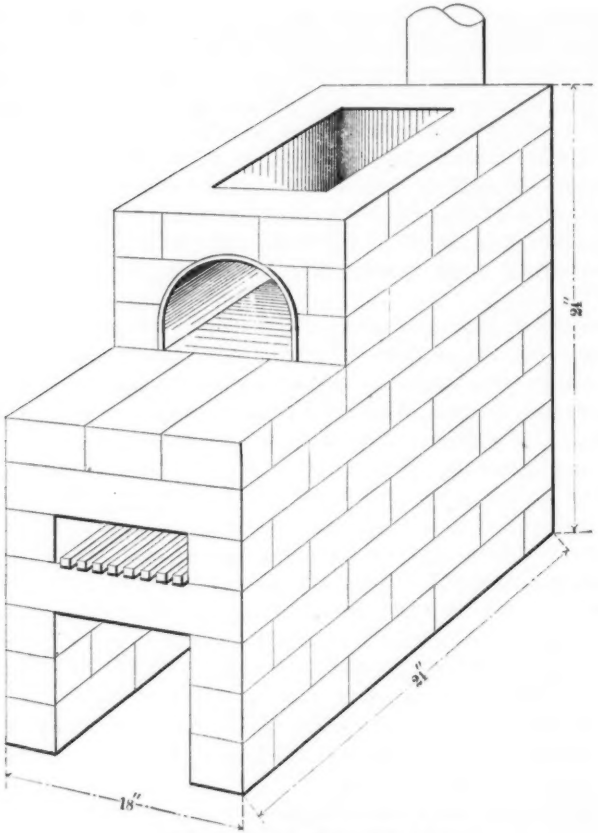
Coal for Making Coal-Dust—As already stated, a long-flaming coal containing not less than 36 per cent. of hydrocarbons, and fairly low in ash, is best. Unless a founder is sure of his dealer he should make his own coal dust. One place manufacturing coal dust for general sale, found a ready outlet for the boiler clinkers by getting confiding foundrymen to buy them ground up in the coal dust. Fifteen or twenty shillings per ton for boiler refuse is not at all bad business for the seller,

It is often possible to buy fine dust or very small coal from the collieries, and to get it cheaper and have it in better condition for grinding than if it were large coal.* Only it must be clean and free from dirt and rubbish. Whether buying coal dust ready ground, or buying coal and making it oneself, it is not difficult to check the percentage of ash present, whether there by nature or by the guile of man. If one has a chemist available, good and well; but failing the trained chemist the following is a practical and accurate test which may be made by anyone:

The apparatus consists of a laboratory scale, two small porcelain roasting dishes, a sheet of glazed paper, a pair of light tongs, and a muffle. A complete muffle heated by gas may be had from any firm that supplies materials to laboratories, but a cheap muffle to burn coke is shewn on page 892. The only part requiring to be specially purchased is the ⊓-shaped muffle shewn built in. The remainder consists of ordinary fire-bricks and a cast-iron grating. The muffle is connected to a chimney.

If the coal dust is newly ground it will contain little moisture, but it is well to put all samples to be tested where they will be dried at a temperature not exceeding that of boiling water. Two pieces of the

* It should be noted that finely ground coal, especially of certain sorts, is subject to spontaneous combustion. Care should be taken not to store it near wooden partitions, posts, or combustible materials.—THE EDITORS.



MUFFLE AND MUFFLE FURNACE.

glazed paper are made to exactly balance each other and on one of these make two separate and accurate weighings of 50 grains of the coal dust. Each weighing is transferred from the glazed paper to one of the roasting dishes, and the two roasting dishes are put in the muffle where they are kept for an hour or longer according to the heat. At the end of an hour take out one dish and allow to cool. Weigh the ash by brushing it onto the glazed paper. Note the weighing, return the ash to the roasting dish and re-insert in the muffle for fifteen minutes. When cool, weigh again, and if the weight is as before then the carbon has been completely burnt. The contents of the two roasting dishes act as a check on each other. Seeing that 50 grains was

the quantity taken, if 6 grains of ash be left then the ash equals 12 per cent. If preferred, instead of weighing the coal dust on the glazed paper take the weight of each roasting dish and weigh the 50 grains in it and proceed as shewn, deducting the weight of the roasting dish* after the final weighing. However formidable this may look, it is really a simple operation and may be applied to the testing of coal by reducing a few ounces to a fine powder and proceeding as detailed.

Testing for ash supplies a complete check upon the seller of coal or coal dust; one has an assurance that he is getting the best materials for the facing sand, and value for the money paid. In addition, should castings turn out rough, the moulder is debarred from blaming "the bad coal dust "as being the cause of the trouble.

Purchase of Blackings and Facings.—Charcoal, and "patent" blackings—that is, blacking made of carbon from oil or gas retorts—are not so subject to adulteration as plumbago is, the high price of the latter rendering it very liable to the attention of the people who desire to cheapen it by mixing impure and cheaper materials with it. When a heavy plumbago is offered at say one penny per pound it is just as well to realise that it is a product of very low quality. The price indicates the amount of incombustible material present. This in one case amounted to 62 per cent. Good quality plumbago should contain under 20 per cent. incombustible material. Buy good quality and use it sparingly, rather than low quality used lavishly.

The test for ash as used for coal dust may be applied to plumbago. It requires, however, a much more prolonged exposure in the muffle than for coal, but will be found worth the trouble. Plumbago is sometimes called "silver-lead." Being neither silver nor lead it is a singularly unhappy name. Plumbago is got in the earth, is believed to be of vegetable origin like other carbons, but retains no trace whatever of vegetable structure. Good plumbago is of a bright grey colour, has a "soapy" feel when rubbed between the fingers, having no grittiness. Its high qualities as a material for making smooth castings appear to be due to its high specific gravity and also to the resistance the condition of the carbon offers to vaporisation by the heat of the molten iron.

Charcoal blacking is best made of the heavier woods, such as oak, and even then it is an objection that charcoal blacking, owing to its lightness, readily washes before the metal. It is quite unsuitable for dry-sand moulds. If it is desired to give weight or body to charcoal blacking an addition of 10 per cent. of plumbago acts in the desired

* This is the preferable method. Paper is so hygroscopic that error may be introduced by changes of weight due to absorption, or loss, of moisture between weighings.—THE EDITORS.

direction, helps to give a good skin to the casting, and facilitates the "sleeking" of the mould. The addition of "patent" or retort-carbon blacking gives weight to the compound but makes sleeking more difficult where green-sand moulds are concerned. Charcoal blacking has usually less than 1 per cent. of ash, but patent or mineral blackings vary from 30 per cent. to 49 per cent. of incombustible matter. The skin desired on a casting may thus be obtained by actual contact of metal and carbon as supplied by blacking, or by hydrocarbons as obtained from coal dust or by a combination of both. Neither of these will make a nice casting of a badly finished mould.

Moulding Sand.—The colour of moulding sand is of no importance. When the sand is red the colour is due to ferric oxide. In yellow sands the colour is due principally to the alumina present. The ferric oxide, however, gives a strong red colour if fully 2 per cent. be present, although there may be over 6 per cent. of alumina, shewing the red oxide of iron to be a powerful colouring agent. Oxide of iron when present as one of the constituents of moulding sand is said to have the power of assisting to put a skin on the casting. If it is so the reason is not clear. It should not be over 5 per cent., as every increase makes the sand more fusible. From 2 to 2¾ per cent. of oxide of iron will be found a suitable quantity.

Alumina may vary from 3.70 per cent. to 5 per cent.—certainly not a wide range. A sand containing 6.34 per cent. of alumina gave trouble by "scabbing" the green-sand moulds, when mixed with black sand in the usual proportions. Sand having 9 per cent. of alumina may be used for dry-sand moulds but is apt to cause cracks in the mould when drying. There should not be any lime, potash, or soda present, as these increase the fusibility, as already mentioned in the case of ganister. Moisture should not exceed 2½ per cent. at most. When moisture reaches 6.10 per cent. in a sand costing over 10 shillings per ton, one is apt to conclude that art has triumphed over nature by means of a water bucket.

Tests for Fineness.—These are made by having sieves of various sizes of mesh, beginning say with 100 to the inch and gradually increasing the size of mesh. A certain weight of sand is weighed or measured and the degree of fineness is gauged by the quantity which passed through each sieve, beginning with the finest, when a certain number of shakes are given. In most cases, however, it will be found that cost of transport is the determining factor as to fineness of sand bought. Certain percentages of silica, alumina, etc., must be present before it can be considered to be moulding sand, but fineness may be

obtained by mechanical treatment in pan mills, or other suitable means. Everyone would buy moulding sand of proper fineness were that always obtainable from the nearest sand banks, or sand pits. When cost of transport for the naturally fine sand exceeds the cost of making fine mechanically, then the latter is the course to adopt.

Storage of Materials.—Pig iron should be piled in blocks of definite form, each grade and brand of iron being distinct. This allows of stock taking of any or all of the irons being made at any time, if it is thought desirable to do so. A monthly stock taking of iron is advisable and quite feasible with a properly arranged pig yard. The cupola records of metal melted will shew how much pig iron of a given brand should be in stock. This is a check against leakage of any kind, if one may apply the term to pig iron. It also prevents collusion by which low-quality irons may be supplied as stock of better quality, should pig-iron maker or merchant be supplying two qualities by agreement with the purchaser. A further check is obtained when the men emptying the trucks and piling the iron give truck numbers, grade, and brand of iron, on which payment is to be made for work.

Storage of Coke.—Coke should, wherever possible, be stored under a roof. Wet coke is considered by some to cause decrepitation in the cupola. It is a reasonable supposition that steam formed in the interior of the coke may so act. It is certainly the case that when coke is wet, if accurate weighing be in use at the cupola, the quantity of burnable carbon put into the cupola will be less than supposed. As nothing can possibly be gained from the water in coke, it is well to have it dry as possible, especially as the coke least able to spare heat will carry the most water, as already shewn.

Fire-bricks should always be under cover, and kept as dry as possible. If they have absorbed any considerable amount of moisture quick application of high temperatures is quick destruction. Often the small service which some fire-bricks give is due more to bad usage than bad quality. If fire-bricks have got wet, a slowly rising temperature which will gradually drive off the moisture is a necessary preliminary to good service.

In the foregoing notes much has been left unsaid, as space will not allow of fuller treatment. In concluding this portion of the subject the author would appeal to the judgment of scientific and honest test as the sole arbiter of what is best to purchase. No buying is so badly done as that which proceeds from bribery. The man who takes secret payment puts himself in the power of one who may one day be his enemy. Nay—he who gives a bribe *is* an enemy, and will have his own again with usury.

THE BETTERMENT OF STEAM-BOILER ECONOMY.

By E. S. Farwell.

The whole animus of modern engineering is economy—of time, of effort, of energy. In studying the advancement of economy, however, we are too apt to confuse our sense of proportion and limit our vision by a close-range contemplation of details. There is sound value and profit in getting back, as Mr. Farwell does in the following review, to the fundamentals—in viewing the elements of the situation largely, and shaping our efforts and studies anew by the main lines, rather than the minor ones, of the problem before us.—The Editors.

IT is often necessary to have some great disaster or trying adversity in order to spur us on to our best endeavors. Nothing in years has aroused in the United States such general interest in fuel economy, as the strike of the past year. This interest is not confined to the industries, but has invaded domestic life. Propositions to save fuel or enable cheaper fuel to be burned in ranges, stoves and furnaces are finding receptive minds and eager investors. With this widespread interest, it will be surprising if American industries do not emerge with a much improved steam plant. It is not the purpose of this article to advocate or advertise any particular device or class of devices, but to indicate some of the most promising lines in which improvement should be sought.

The principles affecting the economy of steam boilers are so simple and well recognized that it seems almost incredible that we have not made more progress than we have during the past century. Notwithstanding all the elaborate experiments and investigations of our scientific men, we still hang the ketttle on the crane, so to speak, and let it absorb what heat it can before the gases go up the big chimney. In school we are taught certain correct principles which we immediately proceed to forget so soon as we are graduated. Some "practical" man tells us that "it may be right in theory, but it will never do in practice." I cannot find polite words to express my condemnation of that statement. If it is right in theory, it is right in practice. To use an expression of the day, it is "up to us" correctly to interpret and apply these unquestionably correct theoretical principles. If our application is a failure, let us manfully admit it is a result of our inability

to appreciate the true meaning of the theory. Not until we shall have arrived at this conclusion is there any hope of advancing our profession.

For a number of years no advance has been made in the efficiency of the boiler plant. I am not unaware that this statement will be disputed by inventors and other interested parties; nor do I wish to be understood to say that some of these so-called improvements are not correct in principle, and more or less so in application. I am speaking of the general practice of the day. We still, after many years and the introduction of expensive equipment, find our boiler plant running on 70 per cent. efficiency. What becomes of the other 30 per cent., and how can it be saved? About 1 per cent. is in the ash, 6 per cent. is radiated, and 23 per cent. goes up the chimney for one cause or another. From a scientific standpoint, it is easy to see how to remedy the first two items. It becomes merely a commercial problem, with the saving effected on the credit side, and, on the debit side, the interest on the investment necessary to make the saving.

The causes which produce the loss up the chimney are many and varied. They may be divided into three groups: those relating to combustion, or the production of heat; those relating to the absorption or utilization of heat; and those relating to the movement of the gases through the fuel bed, flues, and chimney, or to the production of "draft." The first consideration should be to produce complete combustion at the highest attainable temperature. Each pound of coal requires a certain known quantity of oxygen for its complete combustion, no more and no less. Yet we have actually come to believe that it is *necessary* to supply one and a half to two times the theoretical quantity of air if we wish to get complete combustion. A double supply of air practically doubles the energy consumed in the draft producer, doubles the amount of heat carried up the chimney, and reduces the temperature of the furnace one-quarter. The problem is to bring each particle of oxygen into close proximity to the particle of fuel to which it belongs. This must be accomplished before the particles are cooled below the temperature of ignition. If the supply of air is limited to the theoretical amount and introduced entirely through the fuel bed, much of the volatile gases will pass off unconsumed and the remaining carbon will only half burn to carbon monoxide. Part of the air, already heated, may be introduced above the fuel bed, through holes in the side walls or otherwise, but that is only half the solution unless this air is properly mixed with the gaseous fuel. Brick checker work and baffle walls have been used for this purpose,

but usually after the gases have been cooled by contact with the shell or the tubes of the boiler. A maze of steam jets has also been tried, with its consumption of energy. The volatile gases, amounting to from 20 to 40 per cent. of the fuel in bituminous coal, are driven off during the first few minutes after the coal is fired; hence, with periodic or hand firing, the supply of air to be mixed with the gases must be variable. With a uniform feed, as in most stokers, the air supply may be practically constant, and that introduced above the fuel bed may be admitted at the most effective point for an intimate mixture. If the fuel is fed in at the front, it will ordinarily give off its volatile gases while traversing the first foot or eighteen inches. These gases may be confined and forced to pass near or through the bed of fire under jets of heated air, thus becoming thoroughly mixed.

The introduction of steam, both above and below the grate, is sometimes thought to add fuel to the fire. But this is never so. In fact, in making up the heat balance, this will always appear as a loss. One use of the steam jet above the grate has already been mentioned; another will be later. Steam admitted below the grate serves a useful purpose in that, by its decomposition, it forms with the carbon of the fuel a water gas which burns in a flame. This merely transfers part of the combustion to the space above the fuel bed, thus reducing the amount of heat generated on the grates. This saves the grates and prevents the melting together of the ashes into a clinker, so that every part of the fuel bed may get its proportionate supply of air.

The space above the fire bed should be devoted entirely to the completion of combustion before the gases come in contact with any cooling surface. The combustion in your gas jet or lamp flame is complete and perfect. Hold a test tube of water in the flame and note the immediate deposition of unconsumed fuel upon it. Hold a coil of wire about a candle flame and watch it go out. These experiments were once known to most of us, yet we placidly set our horizontal tubular boilers 28 inches above the grate and wonder why we get smoke. And as though that was not bad enough, we have in the wonderful strides of progress of the past decade, built water-tube boilers in which the gases and flame rise from the grate and plunge immediately through a twelve-high bank of tubes. I am informed by a maker of both horizontal and vertical water-tube boilers that the former, with the fire directly below the tubes, are more efficient for hard coal, and the latter, with an exterior furnace, for soft coal. The reasons are not hard to find. We are told that radiation is the most efficient method of transmitting heat; hence, the advantage of the horizontal boiler with the tubes directly

over the fire. With hard coal having a short flame, combustion is practically completed before reaching the cool tubes. But with soft coal, more is lost in the horizontal boiler by the dampening of the flame than is gained by direct radiation to the tube surface. If a furnace could be devised in which the advantage of direct radiation could be retained while the gases were kept from contact with all cooling surfaces until combustion was complete, we would make a long stride in advance. This result has been attempted by the use of a steam jet in the form of a sheet covering the entire furnace and deflecting the burning gases away from the boiler until combustion was completed.

The transfer of heat from the gases to the water is proportional to the difference of temperature. Having constructed the furnace to produce complete combustion without the dilution of the gases by an excessive amount of surplus air, the gases reach the boiler at the highest possible temperature. The water has a uniform temperature corresponding to the pressure carried. The first square foot of heating surface transfers heat very rapidly, and the last square foot very slowly, since the temperature of the gases has now been very much reduced. When we see that the temperature of the water is 350 degrees, we consider 450 degrees very good for the escaping gases. This is still further reduced by the use of an economizer containing water at an average temperature of 250 degrees instead of 350 degrees in the boiler. I have known of a boiler plant in which the gases from horizontal tubular boilers passed through two sections of an economizer in succession, the combined heating surface of which was equal to that of the boiler. In this plant, when a horse power was being developed from 5 square feet of boiler-heating surface, the temperature of gases escaping from the last section was about 260 degrees. This division of the heating surface is in the direction of economy, but it should be carried to the limit. I have recently seen some literature relative to a boiler which claims to embody this principle. It seems odd, however, to see an inventor going to such extremities to force the heated water to circulate downward. The natural tendency of heated water is to rise, and as steam must be liberated from the surface and sediment ordinarily settles, it would seem that the best results would be obtained by employing rather than antagonizing nature. Another fact which harmonizes with this is that those gases which have become cooled most and settle to the lower level are the ones which should be first discarded. In a large number of boiler tests on vertical boilers having top flue connections, I have seldom observed a temperature of gases leaving the boiler below 600 degrees when running the boiler near

rated capacity. It has always been one of the most difficult problems for makers of this type of boiler to prevent short circuiting, and the formation of cold-air pockets. I would suggest that these natural tendencies be taken into consideration; that the heated water be allowed to rise to the top and there converted into steam; that the cooled gases be allowed to drop to the bottom and there drawn off; that the hottest gases be applied at the top to the hottest water; and that the feed water be introduced at the bottom where it will be able to abstract heat from the coolest gases. The water in the bottom of the boiler may be 100 to 200 degrees cooler than the steam, for there need be no circulation and we know that water is a very poor conductor. The effectiveness of the last square foot of heating surface will thus be very much increased, and the temperature of escaping gases should be below 300 degrees at most.

In regard to the third portion of the loss, I can only say that our adherence to the chimney of our ancestors is worthy of a strict Confucian. A fan driven by a steam engine at 6 per cent. efficiency is still far more efficient than a chimney as a draft producer, provided other uses may be found for the heat contained in the gases. As has already been mentioned, this heat may be much reduced by a radical change in the design of our boilers. A further use may be found in heating air or water for warming the buildings, or heating air for combustion.

For an ideal boiler plant, then, we should have a furnace in which the minimum amount of air compatible with complete combustion is thoroughly mixed with the fuel, and combustion is completed before the gases are cooled below the temperature of ignition. The boiler should be so designed as to present at any point in the path of the gases the maximum difference of temperature between the gases and water, and to reject always and only the coolest gases.

THE BRITISH NAVAL ENGINEER UNDER THE NEW SCHEME.

By Charles M. Johnson.

The struggle for fitting recognition of the naval engineer, not only as a matter of justice but as an essential to naval efficiency, is one in which THE ENGINEERING MAGAZINE has taken an earnest part. It is with very great gratification therefore that we have seen the British navy—the greatest navy in the world—follow the lead of the American navy, and go yet further, in placing the engineer corps on its proper plane of dignity. Some comparison of the British scheme with the United States "personnel law" is made in our reviews this month. Mr. Johnson deals principally with the substance of the scheme and the training and position of the engineer under it.—THE EDITORS.

THE proverbial long lane has taken a turn at last in the right direction. The disabilities under which the British naval engineer officer has laboured for so many years have at length been acknowledged by the Admiralty not only to exist, but also to militate against naval efficiency. The engineers of the navy have for many long years insisted on this palpable and irrefutable fact, but few would listen —and those who did, did not believe. But what the engineers of the navy were unable to effect, the almost unanimous consensus of opinion declared by the great engineering institutions and journals of the country has succeeded in accomplishing. The engineer officer of the future will have an executive title, executive rank, and—which is most important of all—executive authority; so that, in the words of the late Admiral Charles Fellows: "he will be able to give an order to any man in the ship, without the possibility of its being disobeyed or even questioned." Whether the engineer officer of the future will be as good an engineer as his predecessor, is a question time and experience alone can solve.

The fundamental basis of Lord Selborne's new scheme is that there shall be one system of supply, one sytem of entry, and one system of training. In the opinion of Lord Selborne and his colleagues, and doubtless also in the opinion of the majority of naval officers, this restriction of supply, entry, and training to one source, and through one avenue, will result in producing "a lifelong community of sentiment." That is to say, that all having entered the service by the same door, studied in the same school, and been companions for the first seven years of their naval careers, it may reasonably be expected that there will be a lifelong community of feeling and comradeship, and that the

professional jealousies and class prejudices which have never been absent from the navy of the past century will hereafter be "historical reminiscences" only. In fact the "New Scheme" is a bid for universal brotherhood among naval officers of the combatant branches. The end sought to be attained is a desirable one, provided efficiency be not thereby sacrificed. The three branches which are recognised in the scheme as forming the fighting arm of the service are the executive, the engineer, and the marine, and it is with these alone that the new scheme deals.

The mode of entry into the service is to be by nomination, combined with a very elementary and limited competitive examination; and the memorandum goes on to state that "in the nomination of candidates, preference will be given—other things being equal—to those boys whose parents or guardians declare for them that they are prepared to enter any one of the three branches of the service, at the termination of their probationary period of service afloat." The successful candidates will be entered at once at the Royal Naval College, where they will remain under instruction for four years. The curriculum will consist of an extension of the present Britannia course, including elementary instruction in physics and marine engineering, with the use of tools and machines in connection therewith.

I pause here, to note what appears to me to be the weak point in this part of the programme of instruction. What is to be the nature of the factory or workshop in which this engineering instruction is to be imparted? What is the description of plant, machinery, and tools, on which their infantile excursions into the practice of engineering are to be essayed? What is to be the class of work on which they are to be employed? Is it to be work of a nature that may be utilised when completed, or is it to be relegated to the scrap-heap? Who are to be the instructors? These and many other such questions will naturally occur to the mind of every practical engineer, who will readily perceive that the making or the marring of this branch of their first period of instruction depends entirely on the answers given to the above and all kindred questions. Unless the foundation be well designed, laid, and constructed, the superstructure can never be of any permanent value. It appears to me that at the best, the instruction in engineering to be imparted during these first four years must of necessity, from the very nature of the curriculum as a whole, be of an essentially perfunctory nature; but if the Admiralty wisely determine that this portion of their programme shall be drawn up by engineering experts, and, as far as possible, adhered to without alteration or modification,

there will be every reason to anticipate that engineering will occupy its rightful poition in the education of these cadets.

The second period of training is to be of three years' duration, and is to be passed at sea in the higher rank of midshipman; and Lord Selborne is careful in his memorandum to emphasise his intention "that special attention will then be paid to their instruction in mechanics and the other applied sciences, and to marine engineering." This is a very satisfactory pronouncement, and the Admiralty may rest assured that the more rigidly this dictum is adhered to, the more useful in every way will be the naval officer of the future. But whilst engineering and the applied sciences are very properly to occupy a prominent place in the training of the midshipman, he is also to be instructed in seamanship, gunnery and torpedo work, navigation, and pilotage. There will be an annual examination in all these subjects, for which the papers will be sent from the Admiralty as at present. But as if to retain some small relic of the sailing navy which Lord Selborne declares has passed away never to return, the final examination at the end of the three years at sea, and the consequent promotion to sub-lieutenant, are made to depend upon the midshipman having successfully passed the final examination in seamanship before a board of three captains or three commanders. On being promoted acting sub-lieutenant these young officers will return to England, and join the college at Greenwich for a three months' course of mathematics, navigation, and pilotage, to be followed by an examination. They will afterwards proceed to Portsmouth for a six months' course in gunnery, torpedo, and engineering, at the close of which they will be examined, receive their classification 1. 2. 3. in each subject, and on passing out, will be confirmed in the rank of sub-lieutenant. This terminates the second course of training. Up to the present time these young officers have all been trained exactly alike, and they have now arrived at that critical moment in their professional careers—the parting of the ways; for it is now to be decided which branch of the executive arm of the service they are respectively to join—the executive (proper), the engineer, or the marine. And when we come to this stage of the new scheme we are not at all surprised that the Admiralty should have emphasised their preference to give nominations to those candidates whose parents or guardians declare for them that they are ready to enter any one of the three branches, as this declaration must greatly simplify the work of the Admiralty in filling up the various ranks; and it is to be regretted that the Admiralty did not absolutely refuse any option of choice in this matter. It would have wonderfully strengthened their

hands, and would have permitted the instructing officers to select the executive, the engineer, or the marine, in strict accordance with the aptitude displayed by the young officers in the course of their training, and their positions at the various examinations. And it must be evident to every thinker that the instructional officers must have far and away the finest opportunities of appraising the bent of mind and the professional aptitude of these young men; their advice—if the final selection be not vested in them—should in any case have very great weight with the Admiralty in allotting the appointments.

As I am considering this new scheme from the engineer's standpoint, it is unnecessary—from this time—to follow any but the career of the "Sub-Lieutenant (E)," who (it may be stated in parenthesis), is now from 19 to 20 years of age, and is now to enter upon the technical and theoretic study of his life's profession. Somewhat late in life, it may seem to some of us, who made acquaintance with the factory and the bench about our middle teens. We can, however, easily afford to give this part of Lord Selborne's scheme a fair and impartial trial; the more so, since the memorandum shows that the duration of the course about to be entered upon, and the programme of the instruction to be given, are still matters "for careful consideration." Considering the complexity of refinement to which modern marine engineering has attained, and the abstruse problems, both phyical and mechanical, which the student of engineering has now to master, it cannot be doubted that at least four years will be required to complete the engineer's education. Lord Selborne tentatively limits it to two years, but it is unlikely that any practical engineer would agree with his lordship on this question. It is undoubtedly the case, that among naval officers of the executive class the idea is prevalent that naval engineering consists merely in knowing which handle to pull or push, in taking care that bearings do not get hot, in ordering the man in charge of the boilers to keep the steam-pressure steady and to take care that he has plenty of water in his boilers, to keep his bilges pumped out, to see that a correct tally is kept of the coal expended per hour, that the proper entries are made in the engine-room register, and that all orders from the deck are promptly and correctly obeyed. These, in the minds of the majority of executive officers, comprise the whole duty of the naval engineer. In fact, as the writer of a recent letter to the *Times* observed (the writer was once an executive officer): "What the service requires is good engine-drivers, not highly educated scientific engineers." Another executive naval officer interviewed on the subject of the new scheme, and described by the interviewer as "one of

the most mechanically-minded officers" of his acquaintance, is thus reported:

> "I disapprove altogether of the coming amalgamation of the executives and engineers. The executive officers should supersede the engineer outside the engine room, and for the purpose receive practical mechanical education. In the engine room we require engine drivers such as you see in charge of engines at Barrow, Elswick. The artificer-engineer class are splendid men, and I always send for them when I want a job done.* The proper place for the highly educated engineer officer from the college is in the designing office or at the dockyards." . .

Admiral Field in a letter to the *Times* with reference to the new scheme, makes use of very similar remarks, in the fifth paragraph of his letter, where he says:—

> " * * The public mind has been much misled, during the controversy of recent years, into overestimating the important duties and responsibilities of engineer officers who are stationed to control and regulate the engines and boilers in a modern ship of war, whereas the designers and manufacturers of these colossal engines and boilers are the persons, in my opinion, entitled to the first place of honour in the public mind, and yet we scarcely ever hear their names mentioned. Pray let us act logically, and if the officers who *drive* the engines are to have executive naval titles, by all means give the same privilege to the designers of both ships and engines."

These quotations from the writings and conversation of executive naval officers (whose opinions have been considered by the leading journal in the empire, and by the *Manchester Guardian*, to be of sufficient weight to justify the editors in reproducing them in the columns of their respective journals), clearly show that there is great difficulty on the part of the executive officers adequately to gauge and estimate the technical and scientific attainments demanded of the naval engineer by the continual progress of the science of engineering, and the ever-increasing complexity of ship construction and naval engines and boilers. Is it attributable to that "little knowledge" which "is a dangerous thing" that the executive officers, living in an atmosphere redolent of mechanics and science of every kind, and who, whether they will or not, must to a certain extent have absorbed some of its ozone—it is attributable to this fact, that they affect to treat naval engineering with such depreciatory permissiveness? I feel pretty confident myself that some of the more thoroughly educated gunnery and

* I am curious enough to wish to know in what ship this occurred, and who was the chief engineer? I do not think there are many chief engineers in the British navy who complacently permit the gunnery or torpedo lieutenant to "send always for one of them (artificer-engineers) when" he "wants a job done."

torpedo officers of the executive class—men who have studied mechanics in connection with their immediate duties, and who have done so in a sympathetic spirit, realising that they could not "run their show" as it is colloquially expressed in the service, unless they have completely mastered the smallest details of their particular branch—these men, I feel convinced, would be the last to underrate or minimise the value of the naval engineer. But I am also aware that the number of such officers in the navy is very limited when compared with the totals of the executive list. Nor do I think it can be doubted that the new scheme is traceable to the fear—present, but strenuously repressed, and never admitted save among themselves—that the engineer was bound to become the most important officer in the navy of the future; and could anything be more distasteful to the successor of Nelson, than that he should have to play "second fiddle" where Nelson reigned supreme? Let me here quote the words of another naval executive officer who has specialised both in gunnery and torpedo work. Writing to the *Times* this officer advocates the reduction of the number of special branches in the navy—the one he would eliminate being that of the naval engineer, for the following reasons:

> "The knowledge of propelling ships and boats by wind power formed the profession of seamen of old. It was common to all in a greater or less degree. The best seaman was he who handled best the propelling power, working his machinery to best advantage with fewest breakdowns, and maintaining it from self-contained resources for the longest period. No man on board knew better than an able captain of old the details of his propelling power as regards spars, sails and rigging. * * * * His chief engineer—the boatswain—could not tell him anything he did not know as regards that most important part of his duty; * * * Cannot my brother officers see that the seamanship of today is knowledge of that power which propels the ship, serves the guns, compresses the air for his torpedoes, gets his anchor up, and his boats in and out? Whoever has the greatest knowledge of these things must eventually come to the top. It is the profession of the fighting sailor, for no sea battles are fought under sail, * * * * Therefore I contend that, * * * * today, every naval officer must be proficient in the power which propels his ship. * * * * The new scheme must be welcomed because it is a great step towards such a consummation."

The great desire of this officer is to get rid of the engineer! And yet, how illogical he is. The whole extract which I have given of this letter is one long argument in assertion of the predominance of the engineer—the officer of whom he proposes to rid the service.

To sum up then my conclusions as to Lord Selborne's new scheme, in so far as its provision will affect the naval engineer officer *of the future*, I think they may be briefly epitomised thus:—

1. That the scheme is conceived in the true spirit which should underlie all reforms—the desire to introduce something which shall be workable, elastic; something which experience may be able to modify and improve as defects present themselves in the developments of the future.

2. That it makes no pretence of finality, but courageously states those points which are still under consideration, or have yet to be determined.

3. That its success will in a great measure depend on the prevalence of sympathetic and liberal minds in those who have to carry out its provisions.

4. That more than all, its success will depend on the thoroughness and depth of the instruction in engineering imparted in each stage of the curriculum; and the provision in the various factories and workshops in which practical manual engineering is to be taught, of the most up-to-date machines, tools, and instructors, that can be procured.

In the foregoing pages of this article, I have considered Lord Selborne's new scheme from the standpoint of its probable success in the creation and training of the naval engineer officer of the future; I now come to consider it in its relation to the existing naval engineer officer. Lord Selborne's opening sentence of the paragraph which deals with "The Present Engineer Officer" must have been read by every engineer officer with satisfaction and hope, and yet as he read, there must have been present in his mind—though possibly not articulately expressed—the wonder why, if his services have been so greatly appreciated by the Admiralty, his place in the navy is henceforth to be occupied by another? But let me quote the paragraph in question. Lord Selborne says:

> "The Board are confident that the naval engineer officer of the future will maintain to the full the high traditions of the present engineer branch, but they feel that this scheme would not be complete if it did not include changes designed to harmonise as far as possible the position of the present officers of the engineer branch with the spirit of the future organisation."

After passing such a high eulogium on the present engineer officers, one naturally expects that it will be followed by the declaration of a generous and liberal policy in respect of the claims which for so many years have been urged on the Admiralty by the engineer officers and by their friends and supporters. It is not very much that they have asked for, and the principal item in their request has been one calculated rather to enhance the value of their services towards the navy

itself than to be of any personal advantage to themselves, *viz.*, that they might be accorded executive rank with its accompanying accessories of title, insignia, and authority, so that in the execution of their multifarious and responsible duties they might have their hands strengthened and upheld by the prestige which executive rank has been wont to confer upon its possessors. The present engineer officers have never—as far as my information goes with regard to their wants and wishes—asked for more than the power and authority to reward and punish the men of their own department; and that, to that extent, they should be granted executive rank with its accompanying titles and insignia. The other changes asked for by the present engineer officers it is unnecessary for me here to touch upon, as they do not in any way bear upon the scheme we are considering. The Memorandum proceeds as follows:

> "Accordingly, the following changes will be made in the designations of rank:—
>
> "Engineer students will become engineer cadets, and the college at Keyham will be known as the Royal Naval Engineering College.
>
> "Assistant engineers for temporary service, and assistant engineers, will become engineer sub-lieutenants.
>
> "Engineers, chief engineers, and staff engineers will become engineer lieutenants.
>
> "Fleet engineers will become engineer commanders.
>
> "Inspectors of machinery will become engineer captains.
>
> "Chief inspectors of machinery will become engineer rear-admirals.
>
> "The engineer-in-chief will become engineer rear-admiral, and the Board reserve power to promote the officer holding that high post to the rank of engineer vice-admiral if thought advisable.
>
> "The average period of reaching each rank will be assimilated as far as possible to that of the executive branch, so as to correct the present disparity of age, which often obtains between officers of the two branches of relatively equal rank; the pay of existing engineer officers will be raised, but no changes will be made in their uniform or in the regulations which define their duties, or in the provisions of the Naval Discipline Act.
>
> "The Board have given their careful and earnest consideration to all the suggestions which have been made from a variety of quarters for further changes affecting the present engineer officers. The decision at which they have arrived is, they are convinced, that most conducive to the interests of the service as a whole."

Lord Selborne and his colleagues must have worn a pensive smile, like Mark Twain's "Mrs. M. R.," when they penned the above sentences. I sometimes wonder whether the Admiralty have grown to believe—because the present engineer officers have waited so long and so patiently for the "turning in the lane"—that these officers can be always relied upon to mistake the shadow for the substance, and to

accept as an unmerited concession any "unconsidered trifle" they may contemptuously fling to them? Unless their lordships do entertain some such opinion as this of the engineer officers of the navy, it is difficult to conceive by what line of reasoning they can have persuaded themselves that such a miserable burlesque of executive rank could be acceptable to the present engineer officers. And, as if it were not sufficiently degrading to these officers to be invested with the mockery of the thing ostensibly granted, the Admiralty have gone a step further, and have provided these officers with titles which will invidiously distinguish them forever from the engineer officers of the future. See table of titles below:

Future Engineer Officers.	Present Engineer Officers.
Sub-Lieutenant (E)	Engineer Sub-Lieutenant.
Lieutenant (E)	Engineer Lieutenant.
Commander (E)	Engineer Commander.
Captain (E)	Engineer Captain.
Rear-Admiral (E)	Engineer Rear-Admiral.

It is painful for any honest straightforward man, who has been accustomed all his life "to call a spade a spade," to have to deal with such casuistry and jesuitical reasoning as are here shown to have commended themselves to the minds of the officials who drew up this scheme. Truly may it be said "they asked for bread and were given a stone." The only consolation to be found in this precious scheme is, that its provisions are subject to modification and improvement as time goes on. Lord Selborne will be well advised if between now and the date on which it comes into force, he shall have removed these blots and disfigurements from an otherwise well-conceived plan of reform.

I cannot close this paper, without giving the readers of THE ENGINEERING MAGAZINE some indication of what—in my opinion—would have been a much more satisfactory way of dealing with the engineering difficulty in the British navy. The drastic reform—it might not inaptly be termed a naval revolution—which Lord Selborne has had the courage to initiate, was not necessary from an unbiassed naval point of view. The navy was geting on with its work in a satisfactory manner as far as the executive branch of the service was concerned, except perhaps that a few ambitious officers were desirous to usurp the functions of the engineer officers, especially in regard to mechanical appliances connected with guns and torpedoes. It was quite unnecessary that the gunnery and torpedo lieutenants should be converted into engineers, or that the engineer should be converted into a seaman.

But what was necessary, and what should have been done, was to strengthen the engineer's position by investing him with executive rank and control in his own department, to increase his staff to a degree commensurate with the vast cares and responsibilities and duties which properly belong to the engineering staff of a ship of war, and to invest him with the supreme control of everything mechanical within the ship, subject only to the direction of the officer in command. I will conclude with some extracts from the letter of an executive officer which appears in the *Times* of today (17th Jan., 1903) over the signature, "A late Captain of a Battleship."

> "Having lately given up the command of a battleship, I think I know to a great extent the opinion of the executive officers on the question of education, and also the proposals of many of the present engineer officers for improving their position on board ship. With these proposals I have always sympathised. * * * * The crux of the whole question turns upon the engineers.* * * * Under the new scheme is the navy to get better engineers than we have now? My opinion of the present engineer officers is that they are most zealous and efficient officers, and that it will be very difficult to improve on them. * * * * If it is only hoped to obtain as good engineers as you have at present, it seems a great and unjustifiable risk to turn the service upside down for the purpose of doing so. * * * The demands of the present engineer officers to better their position are very reasonable. I believe that the enormous majority of them are proud of being engineers, and justly so, and do not wish to be called lieutenants, captains, or even admirals; but they think that their rank should correspond with officers of the executive branch of the same age, and that their pay should be increased, and, above all, that they should have authority to punish men under their orders for technical offenses—in fact, that practically they should be made into a corps. The right of punishing may seem strange to be considered so important, but no body of men can be satisfactorily governed unless the officer in charge of them has the right to decide questions of neglect of duty and to punish those in fault.
>
> "I may say that many executive officers entirely sympathise with the present engineer officers in their claims, which are certainly just, and think that if they were conceded, the result would be more satisfactory than anything that can be possibly obtained under the new scheme."

The officer whose words I have quoted above has so accurately gauged the situation that it is unnecessary for me to add another word. I will say only that if men of his stamp occupied all the seats on the Board of Admiralty, the engineering difficulty which has agitated the British navy for the last forty or fifty years would be solved without requiring a "Revolution" such as Lord Selborne's scheme involves.

EDITORIAL COMMENT

THE idea of a general building for the housing of the libraries and offices of the various engineering associations, together with the provision of an adequate meeting hall to be used for conventions and other gatherings, is gaining in favor in different quarters. All that is really necessary for the active development of the plan is a full realization of the fact that it does not involve the slightest change in the management and relations of the several societies, and that no objection on any such score can be considered as relevant. If, for instance, a realty-holding association should be formed to construct and maintain a building arranged upon the general lines of a great office building, but including in its plan a large auditorium and modern library book stacks, it would make no difference in the relations of the various societies for them to rent office and library quarters and to hire the hall for their several meetings. That such a realty organization should be composed of the governing bodies of the societies might or might not be practicable, but in no case would it affect the internal management of the associations, such as dues, requirements for membership, research work, and the like. At the same time all would have the great advantages of the use of an unparalleled professional library, covering all branches of engineering work; all would have at their services an auditorium for meetings which a properly arranged schedule would keep in constant use; and best of all, the various members would be brought into a contact and association which could not fail to be of great benefit, both personal and professional.

In such a building the expenses would be reduced to a minimum, as compared with the facilities provided, and indeed it is a question whether such a building ought not to be large enough to provide many offices for rent to members for their business purposes. If the latter feature were included there is little doubt that the establishment might be made self-supporting, since the advantages of offices under the same roof as such a reference library as that composed of the collections of the various bodies would in itself be enough to insure a complete rental of all the rooms.

That one of the national societies has already a handsome house of its own is hardly a sufficient objection to the plans. Engineers are notably men of change, and there is no great railway company, for example, which would hesitate to tear down and remodel or remove a newly-built terminal if sufficient advantage could be shown, and no engineer but would advise such action if consulted about it. The position of the engineer in matters relating to business and commerce is growing more and more influential daily, and if all branches of the profession will act together they will find the control and supremacy of the work of the world and the fruits of its development in their hands.

* * *

THE recent action of the British Admiralty in suddenly abandoning their long and stubbornly held position, and

placing the engineers of the navy henceforth on full equality with the "executive" or line officers, is doubly interesting to American engineers. First, it is an unreserved official acknowledgment of the engineers' long-ignored claim to a position corresponding to his real importance on board ship—an acknowledgment from the navy which is at once the most powerful in the world and the most under the conservative influence of old-time tradition. Second, it is a thorough-going adoption, and even extension, of the ideas embodied in the United States Personnel Law, for which this Magazine fought earnestly and consistently. If American initiative has influenced the administration at Whitehall to this excellent reform, let us hope that the vigor with which Britain has now acted will strengthen the mind of the Administration at Washington to make a good law wholly effective in the American navy.

For it must have seemed at times, even to those usually well posted on the progress of events in the United States navy, as if Admiral Melville were almost alone in his fight for the enforcement of the amalgamation feature of the Personnel Law, which President Roosevelt (while assistant secretary of the navy) made so prominent in his report as chairman of the Personnel Board, by his much quoted remark, "On a modern war vessel every officer has to be an engineer." This dictum appealed to us as the forceful enunciation of a great truth, and we have been glad to lend our voice to the advancement of this great scheme of naval progress. Admiral Melville has never varied in asserting his faith in the efficacy of this plan, *if honestly carried out.* But that has been the whole trouble. For a long time it almost seemed that it was the deliberate intention of the naval authorities to make this basic feature of the Personnel Law fail by doing absolutely nothing to enforce it. The younger engineers were transferred to deck duty, but there was no corresponding transfer of young deck officers to the engine room. We are glad to know that an effort, albeit a feeble one, is at last being made to train all the young officers as engineers.

It had seemed that the only man of prominence in the navy who cared for engineering efficiency was Admiral Melville, but the report of Admiral Bradford, chief of equipment, which has recently appeared in its complete form, shows that another high official, and one trained in the old school of deck officers, is also sincerely concerned about the same subject. His remarks are so strong an argument for the accuracy of the President's position that we have given an extract in our Reviews elsewhere in this issue.

Admiral Bradford starts out with the statement that the modern war-ship is a most complicated machine, filled with complicated machinery, and needing men skilled in the knowledge of such machinery to handle it efficiently. He develops this theme admirably, and closes by saying, "Engineering knowledge is constantly required of officers when at sea." We are glad to note that this is not a belated opinion of the Admiral, but that, as given in his report, it is a repetition of a former opinion submitted to the Navy Department. We feel that this frank expression of his views by an officer of Admiral Bradford's standing is a most encouraging sign for the friends of engineering efficiency in the navy, and we hope it will encourage other progressive men of high rank to put themselves on record with Admirals Melville and Bradford, and so hasten the completion of the transition period and bring its fruition in the shape of the modern naval officer—the fighting engineer.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE TRAINING OF NAVAL OFFICERS.

NEW REGULATIONS FOR THE ENTRY, TRAINING, AND EMPLOYMENT OF OFFICERS AND MEN OF THE ROYAL NAVY.

Memorandum of the First Lord of the Admiralty.

AT last the Admiralty has been aroused by the incessant efforts of civilians and by the engineering press to a realisation of the danger in the existing state of affairs with regard to the engineer branch of the naval service, and in a memorandum, signed by the First Lord, and recently made public, the beginning of a new order of things is announced. We say the beginning, because the plan set forth in the memorandum relates, so far as the present is concerned, with the education and training of the men by whom the vessels of the navy are hereafter to be supplied. That this is the right place to begin, all will admit, and if the plan is but carried out with a degree of thoroughness permissible under its provisions it should result in giving the navy an engineering strength and efficiency the lack of which is now its most serious defect.

That such a change was impending, some clearly foresaw. Writing in this Magazine in September, 1902, in comment upon the gloomy forebodings of Mr. Johnson, Mr. McFarland said, referring to the transfer of certain duties from the engineers to executive officers: "As a matter of fact, in my judgment, this is simply the beginning of a movement which is bound to lead to the same results as have been reached in the American navy."

Mr. McFarland called attention to the fact that when Mr. Welles was Secretary of the United States Navy, as far back as 1864 and 1865, he recognised the fact that the thoroughly competent naval officer should be an engineer as well as a sailor. More recently Rear Admiral Bradford, Chief of the Bureau of Equipment and Repair, in the United States navy, said:

"A modern ship of war is one of the most complicated machines in existence. It is filled with machinery of various sorts from one end to the other. The finished ship, ready for service, is of great cost and enormous value to the government. It is worth nothing unless efficiently handled and kept in readiness for service. These duties devolve upon seagoing officers; they must operate, repair and tenderly care for the immense number of living parts of their ships. In intricacy they compare with the arteries, veins, sinews, and other parts of the human body. Is it expected that officers and men who, when placed on board of a ship, make their first acquaintance with this vast number of machines and moving parts, can understand them? Is it expected they will know how to manipulate them if without previous experience and ignorant of their design and construction? It requires no professional knowledge to decide such a question. A great proportion of the repairs now required to the interior parts of cruising ships are caused by a want of familiarity on the part of those who have charge of them. The only possible way that these ships can be kept efficient is to have the officers and men who go in them, and who are responsible for their efficiency, obtain previous knowledge of their internal fittings by supervising their construction. The best engineers found on board of the

modern ocean greyhounds are those from the shops of Glasgow and other great shipbuilding plants. The best locomotive driver is the one who has built his engine and knows every screw, every rivet, and every part in it. There is no doubt that all interior moving mechanism actuated by steam, compressed air, hydraulics, or electricity should be constructed and installed under the supervision of seagoing officers.

"I believe that all seagoing officers should spend a considerable amount of time on shore acquiring a knowledge of the integral parts of the huge and costly machines placed in their hands when at sea and which they must fight and maintain ready to fight."

The result of all the agitation in the United States was the enactment of the so-called "personnel" law, which provided for the amalgamation of the engineer and line, or executive, officers, with the idea of making every officer an engineer, giving positive rank to all alike. The operation of this law has unfortunately been hampered by the absence of an enforcement clause requiring regular alternation of service on deck and in the engine room, and Admiral Melville has repeatedly called attention to the necessity of some order or enactment covering this point, but in its essential features the personnel law of the United States navy is a frank acceptance of the fact that every officer on a modern war vessel has to be an engineer.

In the introduction to the present memorandum, Lord Selborne now takes practically the same position, accepting the facts which have been so forcibly laid before him by Mr. D. B. Morison and the other engineers who appeared before him in deputation about a year ago. After referring to the changes which have resulted from the adoption of steam power, and the development of the modern ironclad, he proceeds:

"In the old days it sufficed if a naval officer were a seaman; now he must be a seaman, a gunner, a soldier, an engineer, and a man of science as well. It is not only that machinery driven by electric, hydraulic, or steam power is every year becoming more complicated in character and multiplying in form, and that therefore a more extensive education in applied science is necessary for specialised officers, but in various ways the need for a more general scientific training has become apparent."

The necessity for unity in action of all departments of the service must be admitted, but under the present system such action is practically impossible.

"The executive, the engineer, and the marine officers are all necessary for the efficiency of the fleet; they all have to serve side by side throughout their career; their unity of sentiment is essential to the welfare of the navy; yet they all enter the service under different regulations, and they have nothing in common in their early training. The result is that the executive officer, unless he is a gunnery or torpedo specialist, has been taught but a limited amount of engineering, although the ship on which he serves is one huge box of engines; that the engineer officer has never had any training in executive duties; that from lack of early sea training the marine officer is compelled, sorely against his will, to remain comparatively idle on board ship when every one else is full of work; and that the spirit of unity has not yet been carried to its full development."

Having this unity in view the new scheme provides for a standard and uniform preliminary training for all three branches. Thus it has been decided that henceforth:

"All officers for the executive and engineer branches of the navy and for the Royal marines shall enter the service as naval cadets under exactly the same conditions, between the ages of 12 and 13; that these cadets shall all be trained on exactly the same system until they shall have passed for the rank of sub-lieutenant, between the ages of 19 and 20; that about the age of 20, these sub-lieutenants shall be distributed between the three branches of the service which are essential to the fighting efficiency of the fleet—the Executive, the Engineer, and the Marine."

The result aimed at is, to a certain point, community of knowledge, and lifelong community of sentiment. The only machinery which can produce this result is early companionship and community of instruction. These opportunities will be secured by a policy of one system of supply, one system of entry, and one system of training.

The details of the system of education

cannot be given here, but, in brief, it includes four years at the Royal Naval College, and three years at sea as midshipmen, all studying alike the theory and practice of seamanship, navigation, gunnery, torpedo work, and engineering. The three years' cruise will be followed by three months at Greenwich in mathematics, navigation, and pilotage, and six months at Portsmouth in gunnery, torpedo work, and engineering; after which the candidates are to be examined and passed on to the rank of sub-lieutenant.

Here comes in the critical point in the system. The sub-lieutenants now are to be differentiated to fit them for the several departments in which their work will thenceforward be applied. The three branches of the executive, the engineer, and the marine will be filled, primarily by the choice of the candidates themselves, but preferably by the selection of the Admiralty. It is assumed that the greater part of the men will leave the distribution to the Admiralty, but so long as human nature continues to be as it is, we may be reasonably sure that the more attractive executive branch will be sought by most. This has been foreseen in the provision for greater proportional pay in the engineer branch, to make up for the greater attraction of the executive branch, but it is more than possible that the question of choice will have to be eliminated altogether, and the men placed by the government where they are most needed.

The vital points of rank and executive authority in their domain have not been overlooked for the engineers, and the necessity for granting these has been realised and accepted. Thus the whole scheme appears to be reasonably complete, needing only the lessons of experience in carrying it out to enable the defects to be remedied. That the plan is the result of numerous compromises is evident from a mere examination of the wording of the memorandum, but when we consider that it was prepared by a board on which no engineer officer had a seat, we cannot but express surprise that it grants as much as it does.

As the scheme goes into effect in July, 1903, seven years must elapse before the first lot of sub-lieutenants will present themselves, under the new system, for appointment in the several branches of the service, and we may reasonably suppose that at least ten years must elapse before any very appreciable effect can be expected in the personnel of the navy. It is devoutly to be hoped that no great naval war may occur before that time, and compel a disastrous exhibition of the true state of affairs existing at the present time.

THE FRICTION OF HIGH-SPEED JOURNALS.

DATA AND RESULTS OF RECENT INVESTIGATIONS IN GERMANY COMPARED WITH EARLIER EXPERIMENTS.

O. Lasche—Verein Deutscher Ingenieure.

FOR a long time the early experiments of General Morin concerning the laws of friction were accepted as conclusive by engineers in all parts of the world, but there is no doubt that this was partly due to the absence of reliable experiments by any other authority. The general results of experience in machine construction, however, led numerous observers to perceive that modern methods of lubrication, together with the high speeds in practical use, caused material modifications in the older laws to be necessary. The experiments of Woodbury, Thurston, and Tower proved conclusively that in many instances the coefficients deduced by Morin were too high, and also that the speed of the rubbing surfaces exerted a distinct effect upon the amount of friction. The question of temperature appeared as an important element in the problem, so that the whole subject has gradually assumed a more complex form than was formerly assumed to be the case.

In the course of the experiments with the high-speed electric locomotives constructed by the Allgemeine Elektricitäts-Gesellschaft upon the Berlin-Zossen military railway it became evident that further experiments upon the frictional resistance of extremely high speed journals were desirable. An extensive series of tests was therefore made by the company, and the data and re-

sults as well as an full account of the methods employed, are contained in a series of papers by Herr O. Lasche in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure*, from which we make some abstracts.

Formerly journals running at high rotative speeds were subjected to light pressures and could be made of small diameter, giving moderate lineal speeds. When heavy loads were to be sustained the speeds were usually slow and the necessary bearing surface was obtained by lengthening the journal. At the present time, however, engineers are obliged to consider bearings in which the speeds are from 1,000 to 3,000 revolutions per minute, while the shafts carry armatures or fly wheels of many tons in weight. These conditions demand journals of large diameter, in order to secure the necessary strength and stiffness, thus introducing the necessity for high circumferential speeds, while it is also desirable that the journals be of moderate length, in order that perfect bearings should be assured, this involving high unit pressures. Under such circumstances it is evident that the results of earlier experiments, conducted under altogether different conditions, cannot be accepted as safe guides in design.

Herr Lasche discusses the experiments of Woodbury, Thurston, and Tower, plotting them in an ingenious system of isometric co-ordinates permitting the exhibition of three dimensions in a convenient graphical manner, and showing that even with the moderate limits within which they were conducted the coefficient of friction varied with variations in speed and temperature, contrary to the experiments of Morin. For modern conditions, however, in which the lineal speeds of the journals are as high as 10 to 30 metres per second in connection with pressures as great as 10 to 15 kilogrammes per square centimetre, these earlier experiments furnish but indications of the necessity for further investigation.

For a detailed description of the apparatus used in the present experiments reference must be had to Herr Lasche's original papers. In general it consisted of a short shaft, supported in its own bearings at the end and surrounded by the experimental bearing between. The experimental bearing was arranged so that a lifting force could be exerted upon it, this bringing the load upon the lower half of the journal box. The lubrication was effected by the ring system and also could be maintained by a continuous flow, while the speed, temperature, and power were capable of independent variation and of continuous and accurate measurement. Electric driving was employed, so that the power was under close control and observation. With this apparatus tests were made with circumferential speeds as high as 25 metres per second, and under pressures reaching 15 kilogrammes per square centimetre, while temperatures above 100° C. were observed, the higher temperatures being artificially produced by electric resistance coils.

The general results of the experiments may be abstracted as follows:

When the speed and the temperature remained constant, the former being 10 metres per second and the latter 50° C., the coefficient of friction was practically constant for all the materials experimented upon, being equal to 0.04, the work of friction naturally increasing with the dimensions of the journal. If the speed and the temperature remained constant it was found that at first the coefficient of friction increased with the speed, until a velocity of between 10 and 15 metres per second was attained, after which further increase in speed produced a very slight effect, the coefficient remaining practically constant.

With regard to the influence of temperature, the experiments of Tower were confirmed in that the coefficient of friction diminished with the rise in temperature, up to about 100° C. When, however, the temperature passed 125° C. the oil ceased to act as a lubricant, and the work of friction became excessive, so that it is advisable to keep the temperature below about 100° C. in practice. This may generally be accomplished by making the bearings of sufficient mass to permit the rapid conduction of the heat away from the bearing. It is also well in high speed bearings to provide an oil reservoir of sufficient capacity to allow time for cooling, in which case the temperature may be kept down by continuous circulation of the lubricant.

So far as materials are concerned, the results of tests with journals of open hearth steel, tool steel, and nickel steel, running

in bearings of gun metal and white metal. showed that no appreciable change was produced in the coefficient of friction. The choice of material may therefore be left to other considerations than those of friction. White metal is to be preferred to bronze or gun metal, for bearings under heavy pressure because it gives gradual warning of heating and wear, instead of seizing the journal, as may occur with gun metal bushings.

The character of the lubricant also is of comparatively small consequence, provided a good quality be used. Sperm oil gave slightly better results than rape seed or imperial oil, but it was evident that the distribution of the lubricant is more important than moderate variations in quality. The oil passages cut in the bushings should be so formed that the lubricant is drawn in the direction of rotation, and sharp edges should be avoided as apt to scrape the oil from the surface which it is intended to lubricate. Herr Lasche, however, emphasises the value of the oil as a cooling medium, maintaining that an oil reservoir of ample size accompanied by an active circulation of the lubricant is the most effective means of maintaining a safe working temperature which can be employed.

In view of the increasing employment of high rotative speeds in large and heavy machinery these later researches upon the conditions surrounding frictional resistance cannot fail to be of great value to the designing and operative engineer.

THE ELECTRIC DRIVING OF MACHINE TOOLS.

A CONSIDERATION OF THE REQUIREMENTS OF MACHINE-TOOL OPERATION WITH ESPECIAL REFERENCE TO ELECTRIC DRIVING.

Charles Day—New York Electrical Society.

IT is becoming more and more fully appreciated that the maximum efficiency in machine shop operation can be attained only by taking into account all the varied operations in connection with their dependence upon each other, and that any attempt to treat a single question by itself must result in an imperfect solution of the problems with which it is connected. There has undoubtedly been much misunderstanding in regard to the advantages and defects of electric driving of machine tools, because it has thus been considered as a thing apart from the operation of the tools themselves, when the question is above all others dependent upon the whole subject of shop operation. The motive power is but one element in the general scheme of which every part should be given its due proportion of consideration.

In a paper recently presented before the New York Electrical Society by Mr. Charles Day, the relation of the requirements of the machine tool operations to the motive power are discussed in connection with electric driving, and some abstracts of his treatment of the questions are here given.

After calling attention to the advantages of the graphical method of analysing the details of the cost of manufactures, the importance of the development of the full capacity of the tool equipment is noted. This development should begin in the pattern shop and the forge department, where the work should be prepared for the tools with full consideration not only of the finished product but of all the operations which it must undergo in the machine shop. Given properly prepared material, in shape for convenient handling and machining, the method of conducting the machine work must be considered as the removal of the necessary amount of material from the proper places, producing a finish of a definite amount and character in the minimum amount of time.

The machining involves three elements, the tool which actually does the cutting, the machine by which the work and the determinate movements are performed, and the motive power by which the machine is impelled. Since the capacity of the machine and the amount of power by which it is driven are entirely within the control of the designer, it is evident that the speed limit of the operation is to be found in the material of the tool. In this respect too much weight cannot be placed upon the importance which the modern high-speed tool steels bear to the efficiency of the machining

process. Ever since the discovery by Messrs. Taylor and White, that the cutting capacity of air-hardened tool steel could be vastly increased by proper heat treatment, the use of such steels has been increasing, and the influence which the adoption of improved materials for cutting tools is having upon machine-tool design is a most interesting element in the question of driving. The possesion of these steels has rendered previous data concerning the cutting speeds for various materials obsolete, and fresh experiments have become necessary to enable the maximum cutting capacity of existing tools to be determined and to permit designs for new machine tools to be given sufficient strength and powering.

The use of electric driving upon existing machine tools has rendered it possible to make such determinations with ease and accuracy, and such experiments have shown that cuts of 3/16 inch in depth with a feed of .0606, could be maintained in cast iron at speeds of 100 to 125 feet per minute. At the present time it appears that the most inefficient part of many shops is the machine equipment, and until this fact is fully realized by the user the maximum output cannot be reached. With existing tools the feeds provided are altogether too slow, while the amount of power supplied and the rigidity of the framing are both out of all proportion to the cutting capacity of the tools which may safely be used.

Having considered the cutting tool and the character of the machine in which it is to be used, the subject of the motive power may be considered intelligently.

"A machine having been designed for a given duty, its maximum and minimum speeds are limited by the character of the work it will do; the number of speeds is determined by the character of the metal machined, and the uniformity of the tool steel and the power required is fixed by the most severe conditions it must meet.

"For the average machine tool present conditions do not demand a closer speed regulation than 10 per cent., as no good means has yet been reached for determining the character of the metal, and in the average shop little is understood about the relations existing between feed, speed and depth of cut for various materials.

"There are two sides to the question, viz.: the refinement of speed required by the various elements with which we are dealing and the possibility of using this refinement to its full efficiency in actual practice. The first set of requirements may demand a speed regulation of 10 per cent., while the second would indicate that it is extremely difficult to use it to advantage in actual practice with present facilities."

It is evident, therefore, that if the machining is to be done to the best advantage the speed of the tool must be under direct and very convenient control, so that any change required for the conduct of the work to the highest advantage shall be made by the operator with such readiness that he may not fail to avail himself of it. Thus the cutting speed for steel depends upon its tensile strength and elongation, while for cast iron several variable elements enter, the hardness being affected not only by chemical composition but also by the method of cooling and the size and form of the casting.

With the existing belt driven tools the methods of changing speeds by the use of cone pulleys and back gearing are altogether unequal to the demands for numerous and immediate speed variations, and unless electric driving can do better it will not prove itself satisfactory for the improved order of things. When the most efficient speeds for all kinds of work have been arranged and tabulated, and the workman has been provided with appliances enabling him to determine the speeds which he is obtaining on the cutting surface, it is absolutely essential that he shall be able to control the speed of the machine from any point where he may be obliged to stand, without having his attention diverted from the work, and without being compelled to go through any such performances as shifting belts or changing gears.

This requirement of ready and convenient speed control indicates that the induction motor is unsuited for the best operation of machine tools under existing conditions. When used with cone pulleys or variable speed countershafts it is no better than the same devices operated from a line shaft, so that there is nothing to be gained by its use. Probably the best results will be obtained by the use of variable-speed motors with multiple voltages, and such a plan with pro-

vision for intermediate speeds obtained by inserting resistance in the field, appears to offer promise. In any desirable system standard motors should be utilized, the controller being operated by a single handle, with the entire range of speeds capable of being passed over while the work continues.

It is evident that electric driving, to be a success, must do so much more than merely replace line shafting and belt driving. It must form a part of the new order of machine-shop operation, in which every tool is being operated at its maximum capacity for the greatest possible part of the time, and in which each piece of work is required to be executed in a predetermined limit of time, fixed by the nature of the material, the capacity of the cutting tool, and the previous experience of the superintendent.

MODERN POWER DEVELOPMENT AND TRANSMISSION.

IMPROVEMENTS IN SUBDIVISION AND APPLICATION OF POWER THE SOURCE OF THE EFFICIENCY OF THE WHOLE PLANT.

Prof. J. J. Flather—American Association for the Advancement of Science.

A LARGE part of the efforts of engineers has been devoted to the attainment of economy in power generation, and each fraction of a pound which has been cut off of the consumption per indicated horse power has been recorded as another step in steam economy. While this has doubtless contributed in no small degree to the improvement of the steam engine, and made for mechanical progress generally, engineers are beginning to perceive that it is quite possible to make a plant too efficient in one part at the expense of increased losses in other portions, and that it is the efficiency of the whole which demands consideration.

The vice-presidential address of Professor J. J. Flather, before the section of engineering and mechanical science of the American Association for the Advancement of Science discusses the modern tendencies in the development and transmission of power in this light, and some very interesting examples are given to show how every detail of a plant is involved in the final efficiency.

In the first place the various elements should be considered in proportion to their relative importance. In nearly all establishments the labor cost is much greater than the cost of both power generation and transmission, so that any expedient by which the labor cost may be appreciably reduced is justified, even though the cost of the power be increased thereby. The expenditure of power is therefore a consideration secondary to the advantages and economical output obtained by its use. These advantages include not only immediate convenience to the operator, but also the ease of arrangement of tools, facility in extension of plant, saving of floor space, and everything which conduces to better utilization of the work of the employees.

Naturally the element in power application which affects most nearly the efficiency of the labor is that of transmission. It is freely admitted that transmission by shafting and belting, even when the line is well planned and accurately aligned, absorbs a large proportion of the power generated by the engine, ranging from 30 to 50 per cent., according to circumstances, and even attaining to 75 per cent. of the total power in instances where the buildings are scattered and distances are excessive. As an example of the extent to which transmission losses may offset the benefits of an economical power plant Professor Flather cites the experience of the Baldwin Locomotive Works, in which it was found to conduce to a higher general efficiency to replace an economical central Corliss engine by a number of less efficient smaller engines in various parts of the works, in order to diminish transmission losses.

Naturally the knowledge of the magnitude of transmission losses with the use of shafting and belting has led to a consideration of electric driving, and in many cases a marked economy has been shown by the substitution of electricity for the older systems of transmission. The efficiency of electrical transmission of power, however, is not always higher than mechanical meth-

cds, as Professor Flather clearly shows. It is common to assume for electric motors in such computations their maximum efficiency, while in actual service the average burden will be not more than two-thirds full load, so that the motor efficiency should not be taken at more than about 75 per cent. Combining this with the generator and transmission losses gives a total efficiency of about 60 per cent. of the power of the engine delivered at the tool.

In considering the advantages of electric transmission, therefore, it is wise to assume that the actual efficiency of the electric portion is not appreciably greater than that of shafting, unless the location of buildings renders the case a special one. The principal gain due to electricity, therefore, must be found in other considerations than those of mere efficiency of transmission, and those other considerations are not difficult to perceive. Thus the ability to arange the position of the machines on the floor may result in a gain of floor space of much greater value than the whole cost of the power used, or it may enable the operators to work to better advantage, and thus increase the output proportionately.

The ability to take the power tool to the work is in many cases a cause of saving in time amounting to far more in money value than the amount of power involved, besides the possibility which it affords for replacing expensive hand labor by power machines and tools. These are the strong points of electric transmission, and it is to such considerations that the works manager must turn, and not to the secondary one of mere power economy.

The method of distribution also comes up for consideration. At the present time much is heard about the great advantages of an independent motor to each machine, but Professor Flather shows that the question should be decided according to the conditions of each case. When individual motors are employed, each motor must be capable of overcoming the maximum resistance of the tool to which it is attached. This means that in many instances its average load will be much less than its most efficient capacity. Thus a planer opposes far more resistance at the moment of the reversal of the platen than at any other time, and the motor must be able to overcome this. For such purposes the motor should be capable of sustaining a large overload for a few moments, and unless the designer understands the nature of the tool to be driven the results may be anything but satisfactory. When there are wide variations in the amount of power required the average efficiency of the motor will be very low, and in such cases it may be advisable to resort to group driving, the electric motor operating a short line of shafting from which several machines are driven. The motor may then be proportioned much more nearly to the average load of all the machines which it drives, since the maximum resistance will never be offered by all the machines simultaneously.

In considering the question of prime movers Professor Flather called attention to the great advantages of the internal-combustion motor when used in connection with producer gas or with the waste gases from metallurgical furnaces. The high thermal efficiency of the gas engine and the lower cost of the fuel used combine to render this the most promising direction for efforts to secure greater economy in the generation of power. The reciprocating steam engine, while approaching its limits, has not yet reached its highest degree of perfection, and higher economy may be expected by the use of high-pressure superheated steam in compound jacketed engines. The question, however, is not so much higher efficiency as it is economy of operation. From this point of view the steam turbine offers advantages superior to those shown by its predecessor. The superior steam economy of the turbine under variable loads, and its marked capacity for temporary overloading without impaired efficiency show that under modern conditions it must become a most formidable competitor of the slow-speed reciprocating engine.

Broadly, then, the tendencies of modern engineering in the field of power generation and transmission are in the direction of greater efficiency, not primarily of the generating machinery, but of the machinery of application, and especially of the labor of the operators. These results being accomplished, steam or fuel economy may well be considered, but it should always be remembered that it is the total efficiency of the whole plant which should be attained.

GEODETIC WORK IN HIGH LATITUDES.

THE MEASUREMENT OF AN ARC OF THE MERIDIAN IN SPITZBERGEN BY THE RUSSIAN-SWEDISH EXPEDITIONS.

A. Hansky—Revue Générale des Sciences.

OUR present knowledge of the figure of the earth is based upon the comparison of various measurements of arcs which have been made upon its surface. These measurements have been made at widely differing periods by means of methods and apparatus of varying degrees of precision, and hence an important element in the whole problem has been the determination of the relative weight to be given to the different data. For this reason it has been thought desirable to repeat some of the earlier measurements, or to make entirely new ones by which they may be replaced or checked. Thus the famous measurements which were made in Peru about 1740 by Bouguer and La Condamine to determine the length of an arc of the meridian near the equator, are being repeated by an expedition under the auspices of the French government, while the work of Maupertuis in Lapland is to be replaced by an arc measured in Spitzbergen, nearly 12 degrees further north, by parties sent out by Sweden and by Russia.

The work of the Russian party in Spitzbergen is described in a most interesting manner in recent issues of the *Revue Générale des Sciences* by M. Hansky, one of the staff of the observatory of Pulkova, who himself was a member of the party and took an active part in the work.

Spitzbergen lying between 76° 31′ and 80° 50′ north latitude, is only about 1,000 kilometres from the north pole, and is practically the furthest land north available for geodetic work, involving the establishment of permanent monuments and stations of definite location. Formerly a great fishing ground, especially for the whale fisheries, the islands are now but rarely visited by fishing vessels, occasional expeditions only being made from Russia and Norway.

The advantages offered by Spitzbergen as a location for the measurement of a polar arc were perceived by Sabine as long ago as 1831, but his suggestion was not followed by the British government. In 1861, as a result of a proposition made by Otto Torell to the Academy of Sciences of Stockholm, preliminary reconnoisances were made by Chydenius and Dunér, and later by Nordenskjold and Dunér, these showing that it was possible to select a number of elevations, all on or near the coast, and thus readily accessible, permitting the construction of a system of triangles extending from South Cape (76° 30′) to Little Table Island (80° 50′), thus permitting the measurement of an arc about 4 degrees in length. When it is realized that the original arc measured by Maupertuis in Lapland was but 57 minutes in length and that even when prolonged by Struve it was extended to 70° 40′ north latitude only, the advantages to geodesy by the accurate determination of the longer arc in the much higher latitude will at once be seen.

In 1897 the Academy at Stockholm proposed to the Imperial Academy at St. Petersburg that the work should be undertaken jointly, this being especially desirable since the islands are claimed to be Russian territory. The proposition was accepted and the work placed in the hands of two commissions, appointed by the Emperor Nicholas II and by King Oscar II. After some preliminary work in 1898, the main expedition started in 1899, equipped not only for the geodetical part of the work, but also for general scientific research, including the botany, geology, zoology, and meteorology of the islands, a portion of the staff arranging to winter there for the purpose.

As an indication of the high scientific character of the work it may be mentioned that on the part of Russia it was under the supervision of M. Backlund, the director of the observatory at Pulkova, with the assistance of MM. Pedachenko and Hansky, the latter being the author of the papers now under consideration, while among the Swedish observers may be mentioned M. Jäderine, the originator of the valauble method of base line measurement by wires, as well as the astronomers Angstrom, Rubin, Larsen, and Frenckel.

Apart from the obstacles due to climatic

conditions, the work in Spitzbergen did not differ materially from geodetic triangulation in other parts of the world. The principal matter of engineering interest is the successful use of the 36 per cent, minimum-expansion alloy for the wire used in the base-line measurement, in connection with the Jäderine system.

The original method of Professor Jäderine involved the use of two wires, one of steel and the other of brass, both subjected to the same tension, and both provided with short graduated scales attached to the ends. By measuring the base simultaneously with both wires, the difference in the readings from the two wires gave the data necessary for the temperature correction. This method, using wires of 25 metres in length, is far more rapid than the former one using compensated bars, and the degree of precision has been found to be quite within the limits demanded to make the base measurement as accurate as the angular measurements. The discovery, by Professor Guillaume, of the fact that the alloy of 36 per cent. nickel and 64 per cent. steel possesses a remarkably low coefficient of expansion, about one-fourteenth that of platinum, has made it possible to use a single wire, since the temperature variations of a measuring wire, when protected from the rays of the sun, or used at night, are so slight that no correction is necessary. The Spitzbergen expedition used the Jäderine system with single wires of nickel steel, and the result, according to M. Hansky, has demonstrated a degree of precision within 1-400,000. The base of 6 kilometres was measured in four days, working each day from eight o'clock in the evening until three or four in the morning.

The rapidity of this work can be appreciated only when the condition of the ground is taken into consideration, the operators wading in mud and water knee-deep, on portions of the base.

The triangulation was conducted without serious difficulty other than that encountered in some places in the construction of the monuments from which the observations were made, it being necessary in some instances to avoid locations deeply covered with ice. With the co-operation of the Swedish expedition, however, all the triangulation was finished toward the close of 1901, including the measurement of a second base, and it is expected that the computations will be completed in about a year from the present. This will give the length of an arc of the meridian of about 4° 10′ in length, at a much higher latitude than has heretofore been measured, and the result must be a valuable contribution to terrestrial physics and geodesy.

MODERN MARINE BOILERS.

A COMPARISON OF THE ADVANTAGES OF THE CYLINDRICAL MARINE BOILER WITH PRESENT FORMS OF WATER-TUBE BOILERS.

H. M. Rounthwaite—Junior Institution of Engineers.

So much has been said of late about the relative merits of cylindrical and water-tube boilers for marine service, that the subject may seem rather threadbare, but in matter of fact it is one to which too much study cannot be given, since upon the satisfactory solution of the problem depends the determination of marine and naval strength and even supremacy. It is especially typical of modern development that the most important features in naval development to-day are its engineering questions. The subject of the training of naval officers is discussed elsewhere in this issue, and here we shall examine the paper of Mr. H. M. Rounthwaite upon modern marine boilers, recently presented before the Junior Institution of Engineers.

Mr. Rounthwaite makes no question about the fact that he is a consistent advocate of the cylindrical "tank" boiler, and that he does not believe in the water-tube type; and in his paper he proceeds at once to make a series of comparisons between the two types, showing the defects inherent in water-tube boilers generally, and also the extent to which cylindrical boilers are free from those defects.

The first feature to be examined is that of the provision for the combustion of the fuel. In the cylindrical boiler internal firing is employed, and hence there is no necessity

for providing an external casing about the furnaces, and nowhere is there a higher temperature externally than that of the steam and water. With the water-tube boiler, on the contrary, the whole boiler must be enclosed in a casing capable of resisting the full heat of the fire, and which must at the same time be practically air tight in order that the outside air may not leak in to chill the surfaces and affect the combustion. In practice such casings have a very short life, owing to the action of the intense heat within, while any attempt to cool them by external air circulation results in the loss of much heat, since only a portion can be utilized for a hot air supply to the furnaces. It is very difficult to maintain the casings in an air tight condition, and the consequence of the inevitable leaks is a reduction in the efficiency of the boiler.

Mr. Rounthwaite compares the character of the combustion in the two types of boiler, showing that the arrangement of the tubes directly over the fire in most forms of water-tube boiler prevents complete combustion. The result is the production of an excess of carbon monoxide, and in addition to the loss in efficiency the gas is apt to re-ignite in the uptake, to the material injury of parts not intended to be exposed to such temperatures.

The relative efficiency of the heating surfaces in the two forms of boiler is also considered and it is maintained that the surface of the tubes of a water-tube boiler is only about 66 per cent. of an equal area in the cylindrical type. The difficulty of cleaning the tubes of water-tube boilers also tends to make them grow less efficient than the corresponding portions of cylindrical boilers, so that the difference in boiler efficiency increases with the length of a cruise.

Questions of deterioration and repair are also cited as being in favour of the cylindrical boiler, the tubes of water-tube boilers being especially liable to corrosion, and difficult of replacement. The great number of joints renders the water-tube boiler especially liable to leaks, and experience has shown that the quantity of water required to replace leakage is much greater with the water-tube than with the cylindrical boiler.

While there is much truth in many of the points which Mr. Rounthwaite has made against the water-tube boiler and in favour of the cylindrical type, there is much to be said upon the other side. In the first place it is not possible to stand still. The cylindrical boiler has apparently reached its limit of dimensions and strength, and higher steam pressures and more rapid steaming are demanded and must be supplied from some source. However satisfactory the cylindrical boiler may be for steady and continuous service, and its continued employment in the finest vessels of the merchant marine testifies to this, no more can be expected from it. Both types have their defects, neither of them at present is completely satisfactory, neither of them can in its present form expect to remain acceptable for naval service under present and future conditions.

The investigations of the Admiralty boiler committee, which have been fully discussed in these pages, show how fully all the points made by Mr. Rounthwaite are already appreciated by naval engineers, but they also show that the cylindrical boiler is not able to meet the demands which are before the designers of naval machinery for higher pressures and the more rapid generation of steam. The necessity for the use of small tubes with the water inside of them is a consequence of the inability of larger shells to stand the pressure without becoming excessively thick. How such water tubes shall be arranged so as to form them into an entirely acceptable boiler for naval use has not yet been fully determined, although many of the elements in such a boiler design have been worked out as a result of experience with imperfect forms. That the coming boiler must consist of such water tubes, however, may be received as an accepted fact, and no showing of the superiority of the cylindrical boiler over the present forms of water-tube boilers can alter the fact. Speed is an absolute necessity in modern naval design, and speed means power. Greater power can be obtained only by improvements in engine and boiler design, and experience has demonstrated that it is along the lines of higher pressure and higher temperatures that greater power and higher efficiencies are to be had in steam engines. These facts being admitted the cylindrical boiler is manifestly out of the

race for such work. It will doubtless long remain the accepted form for merchant vessels and for naval service where the highest speed and power is not essential, but it must fall back into the second place, notwithstanding its long and satisfactory record.

Under such conditions there is little doubt that the change should be made gradually, and that the Admiralty plan of equipping vessels with boilers of both types is eminently wise and proper.

The presence of the cylindrical boilers will insure the maintenance of a certain proportion of the power for general cruising and for port service, while the water tube boilers of various designs can be tested under the conditions of actual service and thus be placed in a situation in which the best type will be evolved by a process of natural selection similar to that from which the cylindrical boiler itself was developed. Doubtless mistakes will be made and money expended, but the result will be a water-tube boiler which must prove acceptable because it will be the survival of the fittest among the products of the ablest practical and scientific engineers of the time.

WATER WASTE IN CITIES.

EXPERIMENTAL METHODS EMPLOYED FOR THE DETECTION OF WASTE IN THE DISTRIBUTION SYSTEM OF NEW YORK CITY.

Engineering Record.

THE question of the waste of water in large cities is most important, especially in view of the demand which is being made everywhere for purer water and the introduction of filtration processes. When there is an ample supply of pure water at hand little attention is paid to the reckless waste which takes place, and thus the community becomes accustomed to per capita consumptions which are out of all proportion to the real amounts needed or really used. As the supply becomes polluted and necessity arises for purification of for the derivation of a new supply it almost invariably becomes necessary to consider the reduction of waste, in order that the real necessities of the population may be intelligently determined. At the present time the whole question of the water supply of New York City is under consideration of a special board of experts, and a valuable preliminary to their researches will undoubtedly be the investigation which the commissioner of the department and the chief engineer are conducting to determine the actual amount of waste now existing.

The method in use, as described in a recent issue of the *Engineering Record*, is that of measuring the flow in the mains by means of a modification of the well-known Pitot tube, and comparing the day and night flow, together with a consideration of the metered consumption. The actual instrument used is known as the Cole-Flad pitometer. This consists of an arrangement of two tubes of which the ends are bent at right angles to the principal length, these being inserted into the main so that one pipe has its end turned against the current of the water and the other pipe is turned with the current. The difference of pressure in the two tubes is measured by connecting them to a U tube containing a mixture of carbon tetra-chloride and gasoline, this having a specific gravity of either 1.25 or 1.5 according to circumstances. The displacement of the liquid in the U tube is a measure of the pressure produced by the current, as distinct from the total pressure in the main, and by the use of tables or curves the quantity of water flowing through the main can be closely computed from the indications of the instrument. Since it is important to obtain records of the flow at various portions of the day the instrument is provided with a photographic recording attachment, so that when once connected the pitometer may be left attached all night, and the record made upon a moving band of photographic paper taken off in the morning and preserved for reference and computation.

"The system as applied in New York is as follows: The city is divided into large districts, the boundaries of which are so selected that the entire water supply for each can be made to pass through one or two large mains. These mains are tapped under pressure and a 1-inch corporation cock

attached, through which the tubes of the pitometer are inserted when it is desired to obtain a record of the quantity of water flowing into that district. The instrument gives a continuous record of this quantity. At the same time inspectors are sent around to obtain the figures for the quantity of water supplied to the district through meters. The population of the district is also obtained, either from the city census records or by the inspectors, who also obtain as accurately as possible the figures for the non-resident population and any other significant data.

"The total metered consumption of the district being deducted from the total amount supplied to the district as measured by the pitometers, the difference shows the amount of unmetered consumption plus the waste. Under ordinary conditions, this difference for the hours of 2 to 4 a. m. measures the amount of waste in the district. Local conditions may modify this conclu, sion, however, as in the case of one of the districts considered in New York where the pressure is not great enough to supply the upper floors of the buildings during the day, and especially in the large apartment houses tanks have been provided on the top floors, which are filled during the night for use the next day. Special conditions like this may affect very appreciably the night consumption of water, and it requires considerable experience to be able to interpret correctly the results of such investigations. If the amount of waste and leakage is found to be enough to warrant further investigation, the large district is subdivided into smaller ones and a similar process is followed until the trouble is located."

Several reproductions of the photographic records of the apparatus are given from the report of the official tests in New York, and the results are interesting. Thus an 18 hour record of a 12 inch main in the heart of the city showed that all night long the rate of flow through the pipe did not fall below 1,700,000 gallons per 24 hours, while the maximum day flow was at the rate of only 2,070,000 gallons. The large night flow was undoubtedly due to the filling of large tanks in hotels and apartment houses for use the next day, showing the extent to which this practice equalizes the demand upon the water supply system. Reports from several of the districts of New York are already complete, and the principal results are given in condensed tabular form. On the whole the wastage appears to be principally in the buildings, due to defective plumbing, and one of the immediate results of the work has been the correction of many such defects. There is a marked difference in the per capita consumption in districts of different character. Thus in an excellent residence district the per capita consumption, including waste, ranges from 175 to 223 gallons per day, while in a tenement district it falls to 37 gallons. Doubtless the reasons for this are apparent to those who have made the inspection of the respective sections of the city, and when the work is fully completed it may be possible to discover some definite relation between the character of the districts and their relative water consumption.

THE FUTURE OF GAS LIGHTING.

DEVELOPMENT OF COAL GAS AND ALLIED ILLUMINANTS—HIGH CALORIFIC POWER DESIRABLE FOR INCANDESCENT BURNERS.

Prof. Vivian Lewes—Society of Arts.

GAS lighting presents a most interesting phase in the history of applied science, affording in itself an excellent example of the manner in which apparently insuperable obstacles have been overcome by the use of scientific methods in commercial operations.

Those who can recall the flurry which followed the introduction of electric lighting, when it was supposed for a time that lighting by gas was doomed, will appreciate the position which illumination by gas has since attained, and there is every reason to believe that continual improvements will continue to make gas a successful competitor with other methods of producing artificial light.

The interesting lectures by Professor Vivian B. Lewes, delivered before the Society of Arts, and published in the *Journal* of the society, give an excellent idea of the improvements which have been made in gas

lighting in recent years, and indicate clearly the lines along which progress may be expected.

The weak feature in gas lighting for a long time lay in the very imperfect methods used in burning it, gas of excellent illuminating power being used in burners which utterly failed to utilise the fair value of the gas. This fact was hardly understood, even by those who should have known better, so that there was a continual demand for a richer gas, with the idea that this would provide a better light in the defective burners then in vogue.

When, however, the Welsbach incandescent mantle was perfected, in 1892, a new era in gas lighting was begun, an era which has opened up lines of development which are far from being exhausted. Professor Lewes describes the Welsbach mantle as being simply an improved method of enrichment of the gas. The illuminating power of coal gas is well known to be due to the raising of particles of solid carbon to incandescence. Enriching the gas means simply providing a greater proportion of carbon to become incandescent. Instead of putting the incandescent material in the gas, Dr. Welsbach hung it over the flame once for all, or at least for a comparatively long period, thus enabling a gas low in carbon particles to emit a brilliant light. Apart from the brilliancy of the illumination thus secured, the important feature of the incandescent system is the fact that it permits the successful use of a non-enriched gas and thus enables a marked reduction in the cost of illumination to be secured. The Welsbach burner itself uses far less gas for a given illuminating power than is possible with other forms of burners, but apart from this advantage, its illuminating capacity does not depend upon the richness of the gas, but upon its calorific power. Since it is altogether possible to make cheap gas of high heating value it is of great importance that the incandescent burner shall come into universal use, so that a gas of low illuminating power and high calorific value may be acceptable to all customers.

At the present time some legislation may be necessary to permit this desirable result, since present enactments provide for a standard of illuminating value for coal gas, below which standard the manufacturers may not go. This standard is a photometric one, being, in England, a value of 16 candles when used in a standard argand burner. In order that possible economies may be attained and a corresponding reduction in the price of illumination be secured, there should be a new standard adopted, based upon the performance of the gas in some form of modern incandescent burner, and ultimately this will doubtless be done.

Admitting the importance of producing a low-priced gas of high calorific value for use with incandescent burners, Professor Lewes proceeds to show how this may be obtained by the admixture of water gas with ordinary coal gas. Water gas, produced by passing steam through incandescent coke or anthracite, contains about 52 per cent. of hydrogen and 38 per cent. of carbon monoxide, with small quantities of carbon dioxide, oxygen, and nitrogen. Of high calorific value, this gas requires carburetting before it can be used directly as an illuminant, and, thus enriched, it is used in many places, notably in the United States. Used directly as a diluent for ordinary coal gas, however, it would serve to diminish greatly the cost, and at the same time enable an excellent calorific value to be maintained, although the illuminating value would be lowered when used in ordinary flat-tip burners. With Welsbach mantles, however, such a mixed gas furnishes a brilliant light, enabling the cost of lighting to be reduced to a point where competition appears to be practically impossible.

The great objection to this method of obtaining cheap lighting is the proportion of carbon monoxide in the gas. The poisonous nature of this gas is well known, and many objections have been made to the permission to distribute such a mixture throughout cities, because leaks would be far more generally fatal than with the less poisonous coal gas. Professor Lewes shows that this objection is not nearly so serious as at first appears. Ordinary coal gas contains from 5 to 10 per cent. of carbon monoxide in nearly every case, and Professor Lewes maintains that practical safety is not further endangered if the proportion does not exceed 16 to 17 per cent. If the limit is fixed at 16 per cent., it would be practicable to take an ordinary coal gas,

containing 5 per cent. of carbon monoxide, and increase its bulk by the addition of carburetted water-gas until the mixture contained 52 of coal gas and 48 of carburetted water gas. If blue water-gas were used the limit would be reached when the mixture contained 66 per cent. of coal gas, and 34 per cent. of blue water-gas. Thus, to 100 volumes of coal gas there may be added 92 volumes of carburetted water-gas, or 51.5 of blue water-gas before the limit of 16 per cent. of carbon monoxide in the mixture is reached.

Such a gas is naturally best suited for use with some form of incandescent mantle, and Professor Lewes discusses a number of investigations both in Europe and America which show conclusively that under such conditions the light emitted is practically proportional to the calorific power of the gas, and that its illuminating power as ordinarily understood does not bear upon its value for use with mantles at all.

So far as the mantles themselves are concerned, improvements are to be expected from the various fibres which are now the subject of experiment. The composition itself, consisting of 99 per cent. thoria and 1 per cent. ceria, appears to be the best which can be obtained with present knowledge. The Welsbach mantles use cotton fibre, but the Lehner fabric, composed of artificial silk, made from collodion, gives a more brilliant light and a far longer life, but such mantles are naturally more expensive than those made on a cotton fabric. The experience of Buhlman, of Berlin, with mantles made on ramie fibre, have given most encouraging results, and microscopic enlargements of the various mantles, before and after burning off the combustible portion show the differences in structure very clearly.

These lectures, covering, as they do, the latest state of the art of illumination by gas, should stimulate progress in the direction of improvement, both in the supply of a gas of high calorific power at a moderate price, and in the introduction of high-grade incandescent burners in which to use it.

PROBLEMS IN AERIAL NAVIGATION.

AERODYNAMICS AND THE INFLUENCE OF WIND FORCES UPON THE DEVELOPMENT OF BALLOONS AND AEROPLANES.

R. Soreau—Société des Ingenieurs Civils de France.

AMONG the numerous discussions which have appeared of late concerning the problem of aerial navigation, by far the greater part have been empirical in their character, relating to details of the constructions of machines or to their experimental operation with but little regard to the scientific principles involved in the work to be accomplished. Under such circumstances the scholarly paper recently presented before the Société des Ingénieurs Civils de France by M. R. Soreau, and published in the *Mémoires* of the society, is most welcome, constituting as it does a résumé of our present knowledge of the science of aerodynamics and the part played by the wind in the problem of aerial navigation. The valuable paper by Mr. Neilson in our issue of January last shows how imperfectly the action of wind forces upon stationary structures has been understood, and it is not surprising that the behaviour of air currents above the surface of the earth should be a matter of uncertainty. When we consider the movements of the air with relation to objects fixed upon the surface of the earth we find many phenomena produced solely by the fact that the motion of the wind is opposed by the structures with which it comes in contact. An object floating above the surface, however, is entirely immersed in the mass of air, partaking of its movements much in the same manner as the passenger in the railway train moves about unconsciously while going at express speed, and there is no appreciable resistance of any sort. Thus, if we can imagine two balloons floating side by side in a current of air, one of them, if provided with propulsive machinery, may circle about the other or perform various evolutions with regard to it, quite independently of the velocity of the common current in which they are both immersed, and altogether regardless of the direction of motion with regard to the surface of the earth beneath.

It is only when an attempt is made to direct the machine as regards the position of objects which are not moving in the same current of wind that the difficult element of opposing wind resistance must be encountered, the only air current otherwise met being that due to the movement of the balloon itself. For these reasons it is a mistake to consider the movements of the air with regard to the ground in considering the motion of a machine through the air. M. Soreau discusses the effect of sudden squalls, and of the variations in the velocity of air currents treated by Professor Langley in connection with the internal work of the wind, showing the action of such variations as affecting the problems of sailing flight.

Considering the dirigible balloon, one of the most important problems is that of its stability, as has appeared both from theoretical and practical considerations. An important element in this respect is the completeness with which the gas bag is distended; and the introduction of the *ballonnet,* or internal balloon, capable of being distended by pumping air into it, is a valuable detail in modern balloon construction.

The difficulties of pitching, which have appeared conspicuously in connection with the spindle-shaped balloons generally used in modern experiments, are partly remedied by the use of the ballonnet, but much may also be accomplished in this respect by the exercise of judgment in determining the shape of the gas bag affecting the position of the centre of pressure. Thus Col. Renard, in the famous dirigible balloon, "La France," which operated successfully as long ago as 1884, used a gas bag in which the greatest diameter was well forward of the middle of its length, and by placing the rudder in the rear and the propeller in advance, a fair degree of stability was secured. The use of internal partitions in the gas bag has been found to diminish the pulsations otherwise contributing to instability. The guide rope, used by Santos-Dumont, is considered by M. Soreau as undesirable, introducing the periodical action of the pendulum into the vibrations in an objectionable manner.

In discussing the aeroplane, as the probable successor of the dirigible balloon, M. Soreau shows that the former may well be considered as derived from the latter. Making the gas bag of a dirigible balloon of more resistent material, and inflating it to a high degree of tension, we have to a certain extent a supporting surface apart from the fact of its ascensional force. When this is propelled at a sufficiently high rate of speed certain vertical reactions are produced, according to the shape of the balloon, but of the same general character as those sought in the aeroplane.

Considering the aeroplane generally, M. Soreau calls attention to some important principles affecting its construction. Thus, the limits of the angle of inclination are very small, ranging between a few degrees only. If a greater angle is taken the air strikes the wings from below, and a sudden fall follows, as was the case with Lilienthal in his fatal experiment. If, on the contrary, the angle is too flat, the aeroplane will make a gradual, sloping descent. The question of stability is also a difficult matter. The bird, having independent control over both wings, can vary the position of either, and thus correct its balance as may be necessary, as regards transversal position. So far as longitudinal stability is concerned, it depends upon the relation of the centre of pressure to the centre of gravity, the couple varying according to the inclination of the aeroplane. M. Soreau rightly calls attention to the mistake which may be made in carrying imitations of the bird too far, and as he says, it would be as illogical to attempt to imitate the movements of the wings of a bird in flying as to copy the motions of the legs of a horse in designing an automobile.

The closing portion of the paper of M. Soreau consists of an excellent treatise on aerodynamics, of which we can give but a brief abstract here. The laws of the resistance of the air are but imperfectly known, as indeed are those of fluids generally. In view of the difficulties which surround the study of hydrodynamics it is not surprising that the motion of a solid through the air should require study and experiment. Taking the experiments of Marey, Canovetti, and Le Dantec, it is shown that the resistance to the movement of a body through the air is directly proportional to the area, and proportional to the square of the velocity. When the surface is

inclined to the direction of motion, however, the question becomes more complicated, and suction may be produced in consequence of the reaction of the displaced filaments, in a manner similar to that found by Irminger in the action of wind upon large gas holders.

This action is much less apparent with surfaces of small size than with larger ones, and hence it is advisable to use a number of small planes, which may be conveniently arranged in a manner similar to the well-known Venetian blind.

The theories for the action of a current of water upon an inclined surface, as deduced by Beaufoy, Gerlach, Joessel, and Rayleigh, are discussed, but the experiments of Langley show that these are not applicable to the air. Langley's experiments are discussed at length and reduced to a general formula as well as to a diagram giving the relation of the sustaining power at various angles to a normal pressure upon a plane. This portion of the discussion may well form a starting point for future experimental researches, and constitutes a valuable contribution to the little-studied science of aerodynamics.

IMPROVEMENTS IN INTERNAL-COMBUSTION MOTORS.

RECENT EXPERIMENTS WITH THE IMPROVED BÁNKI MOTOR, USING GAS AND LIQUID FUELS.

E. Schimanek—Verein Deutscher Ingenieure.

WE have referred in these columns already to the improved internal-combustion motor designed by Herr Donat Bánki, of Budapest, and the excellence of the results which have been attained with recent forms of this engine renders it a subject for comment, especially in the light of tests made by Professor Schimanek, published in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure.*

It is well known that one element in high thermal efficiency of internal-combustion motors is the use of high compression of the charge prior to ignition. The usual limit to high compression is the igniting temperature of the charge, and, in fact, explosions of air compressors have taken place by reason of the heat of compression vaporizing and igniting the heavy oil used as a lubricant. The Diesel motor utilises this fact as a means of igniting the charge, but in that type of motor the air is compressed alone, the fuel being injected only after the full compression pressure has been attained, and hence the limit to the compression is found, not in the ignition temperature of the charge but in the mechanical details of construction.

When the charge of gas or vapor and air is drawn into the cylinder in a mixed condition, ready for ignition it can be compressed safely only to a point below its igniting temperature, otherwise detrimental and even dangerous pre-ignition will occur. In order to permit the use of high compression without the danger of premature ignition, Herr Banki adopts the expedient of injecting into the charge a spray of water, atomized into finely divided particles like mist, and mingled with the charge as it is drawn into the cylinder. The presence of the moisture raises the ignition temperature of the mixture very materially, so that not only is there no danger of premature explosion, but the aid of a hot tube is required to ignite the charge at the proper time to produce the propelling explosion. The moisture present in the cylinder expands with the heat of the explosion and adds its expansive force to that of the charge, thus returning as power the heat which it has absorbed, and hence the thermal efficiency of the machine is practically unaffected by the presence of the water.

The use of water in the cylinder of an internal-combustion motor is by no means new, having been used in the old Hugon engine shown at the Paris exposition of 1867, but it was there employed only to cool the cylinder, as a substitute for the water jacket. In the Bánki motor, however, the water jacket is retained, and the finely atomized water is considered as a portion of the fuel charge.

Professor Schimanek examines the thermal conditions dependent upon the use of different percentages of moisture, for a compression of the charge to one-tenth of its initial volume, and shows that for constant

specific heat the temperature of the charge without the water would be 1030°C., giving a theoretical thermal efficiency of 61 per cent., while with a ratio of 0.08 of moisture to air, by weight, the temperature of compression is lowered to 530°C., and the theoretical thermal efficiency still remains as high as 58.4 per cent.

Professor Schimanek describes in detail tests upon Bánki motors using as fuel benzine, alcohol (spiritus), and gas, tabulating the results very fully. Indicator diagrams show a compression pressure of 12 to 15 atmospheres and explosion pressures of 35 to 40 atmospheres, while the thermal efficiency per brake horse power was as high as 31 per cent.

The improvements in the present motors over those of earlier design are mainly in mechanical construction, and in the apparatus for spraying the water into the entering charge, the principle of the machine being practically the same as that originally show at the Paris exposition of 1900. The present engines, however, are of small power, ranging from 3 to 10 horse power, which renders the big thermal efficiency the more notable.

An interesting phase of the experiments, described by Professor Schimanek appears in the adaptation of the principle to the motor of an automobile. A gasoline vehicle of the well known de Dion-Bouton construction was taken and the cylinder head of the engine removed and replaced by another constructed so as to increase the compression from 1:3.6 to 1:5.81, and a device for spraying water into the charge was attached. Brake tests of the motor showed an increase in capacity of about 30 per cent., while the cooling effect of the water was very marked. It is probable that this principle may therefore prove of value on connection with motors of vehicles as well as for stationary service.

While the principle of injecting or spraying water with the charge of internal combustion motors may prove advantageous in permitting the use of higher compression ratios, it appears to be limited to a certain class of fuels which are still ignitable under the conditions then existing. The original motor of Bánki operated with benzine only, while those tested by Professor Schimanek used benzine, a mixture of alcohol and wood spirit, and also gas. With heavier fuels there may be found difficulty in igniting at all and it seems as if the method is applicable only to engines using gas, or the lighter hydrocarbons. The experiments with the de Dion-Bouton motor showed that the presence of the moisture did not interfere with the electric ignition, which confirms the practicability of employing the system for automobiles, but the great demand is for an engine which will be able to use the heavy oils, such as kerosene, petroleum residue, and similar fuels, which at the present time require either the use of some form of vaporizer, or such high compression temperatures as are employed by Diesel.

All these experiments are on the right track, however, and there is little doubt that the pressure which is being exerted upon the problem of the perfection of the internal-combustion motor will result in many advances, in both mechanical and thermal features.

MOTIVE-POWER MACHINERY IN AMERICA.

THE PRESENT STATUS OF STEAM, GAS, HYDRAULIC, AND OTHER PRIMARY POWERS IN THE UNITED STATES.

Edward H. Sanborn—U. S. Census Report.

ALTHOUGH it has thus far proved impracticable to obtain census figures showing the complete status of any department of industry at any one time, yet the results of the census of 1900, now being given to the public contain much valuable information, and cover enough ground to enable some very useful conclusions to be drawn.

The report of Mr. Edward H. Sanborn, upon motor-power appliances, admittedly covering only about one-third of the aggregate value of the products of the establishments from which the data were derived, cannot be used to deduce relations of wages, capital, or labor, but it will be found valuable as regards the products themselves. Taking the census year, 1900, only into ac-

count, the following general results may be abstracted from Mr. Sanborn's report:

By far the greatest amount of power machinery produced during the year was for use with steam. Thus there were 40,533 steam boilers, aggregating nearly 3,000,000 horse power, produced, and 29,120 steam engines, representing a little more than 2,000,000 horse power. Of other kinds of power machinery there was about 165,000 horse power of internal-combustion motors, and 370,000 horse power of hydraulic motors.

The distribution of this large amount of power among machines of various types is a matter of much interest, as bearing upon the development of improvements in different lines. Thus almost exactly one-third of the boiler horse power constructed was of the water-tube type, the water-tube units averaging four times the size of the fire-tube boilers. Steam engines are classified according to the well-known types of plain slide-valve, high-speed automatic, and low-speed automatic. Of the first class there was about 650,000 horse power built, mostly in small sizes, averaging 30 horse power; of high-speed automatics about 300,000 horse power is recorded, in units averaging 82 horse power; while of the slow-speed automatic engines, such as the Corliss there was built nearly 850,000 horse power, mostly in large units for power stations, rolling mills, and other heavy work.

Internal combustion engines, other than those used for automobiles, footed up 164,000 horse power, the average unit being about 9 horse power, while turbine water wheels represent about 300,000 horse power, this last quantity being very indeterminate, however, owing to lack of information as to the head of water under which some of them were to be used.

The data as to the cost of equipment is interesting and shows the extent to which modern methods of manufacture have affected the prices of motive-power machinery. Thus, fire-tube boilers cost $9.28 per horse power, while water-tube boilers averaged only $7.73, this difference being doubtless partly due to the fact that the latter type was built in larger units. For steam engines the prices for the types of plain slide-valve, high-speed automatic, and low-speed automatic, are respectively $12.11, $10.43, and $11.59, per horse power. The small size of the internal combustion motors brings their cost up to $33.88 per horse power, besides which it must be remembered that having but one power stroke in every four, such engines are necessarily larger for their power than steam engines. Since they do not require any steam generator, however, they may be compared with the cost of both engine and boiler in considering the installation cost of a power plant.

The report contains interesting tabulated information as to the manufacture of power machinery classified by states, and is an important document for study in connection with the development of manufacturing industries by geographical locations. For this the reader must be referred to the original report. It is worth mentioning, however, that the total output for the year 1900 was primary power machinery representing 2,743,325 horse power, with a value of $35,120,218. This does not include locomotive engines, nor motor vehicles, but does include marine machinery.

Considering the development of power machinery during the decade covered by the census, some interesting features are noted.

In steam machinery the improvements have been mostly in matters of detail dependent upon local conditions. Water-tube boilers are increasing in use, and superheating is more generally considered of late, although by no means so much used as in Europe. Mechanical stoking is becoming more general in cities where smoke prevention ordinances are enforced. In both engine and boiler practice modifications have been introduced in response to the demands of the large power house erected for electric power generation. Boilers are installed in larger units, and the houses are equipped with conveying apparatus for coal and ashes. Direct-connected electrical generating sets, with the dynamo rotor mounted upon the engine shaft, have included the design of engines from 5,000 to 8,000 horse power rated capacity, these engines being almost universally of the compound type, with trip valve gear and condensation. The triple expansion engine, while holding its own in marine practice, has been generally superseded in stationary practice by the compound engine, with cylinder ratios of larger value than formerly, ranging from 1 to 4 up to 1 to 7, this latter propor-

tion being practically the same as that existing between the high and low pressure cylinders of a triple-expansion engine, the intermediate cylinder being omitted. The steam economy is almost the same in the case of the triple and the compound engines in the latter case, while the machine is materially simplified in construction and operation.

The steam turbine is taking its place as an article of manufacture, being now well past the experimental stage, and it will doubtless figure in a large degree in the statistics of the next 10 years.

In like manner there has been a marked activity in the development of internal-combustion engines, and units up to 1,000 horse power, for use with blast furnace gas are under construction. This form of prime mover bids fair to displace the steam engine in many situations, and holds out greater promise of economy than any other motor.

The development of water power for the generation of electricity at moderate cost has led to a revival in the use of water power, the plant at Niagara being extended and work on the Canadian side being well under way. The possibilities of the utilization of high heads of water with moderate volume has led to the development of impact wheels of moderate size and cost and of high efficiency, and the conditions attending the use of jets of water at great velocities have materially modified the methods of governing the speed of such motors.

The whole report of Mr. Sanborn is a most valuable contribution to the statistics of engineering, and its wide distribution and study should lead to a full appreciation of the importance of collecting such information in all departments of industry.

METAL-WORKING TOOLS.

THE INFLUENCE OF CUTTING ANGLES, MATERIAL, AND TREATMENT UPON SPEEDS AND FEEDS FOR METAL-WORKING TOOLS.

H. F. Donaldson—Institution of Mechanical Engineers.

AN important element in successful works management consists in the ability to extract the greatest possible output from the machines with which the work is actually performed. In the average shop, under what was formerly considered good management, the establishment charges, including everythisg which could not be directly classed as productive, amounted to about as much as the wages of the productive workmen. That is, the shop cost of an article consisted of the material, the wage cost and an expense burden equal to the wage cost. It is now well understood that the most effective method of reducing the shop cost of an article is to reduce the relative expense burden by increasing the output, the burden remaining nearly constant, and therefore the proportion to be borne by each element of the product diminishing. It is therefore most important that the tools with which the work is performed should be operated at the highest degree of efficiency, and every means which can be reasonably employed to secure the best operative results must be welcomed.

In a paper recently presented before the Institution of Mechanical Engineers by Mr. H. F. Donaldson, the influence of the cutting angles of tools for metal work, as affecting speed and feed is discussed in the light of experiments conducted by the author, and some interesting facts brought out. Since a tool is made to cut, the conditions under which it can cut to best advantage must be ascertainable. The variable elements in the tool itself are the material of which it is made and the shape which is given to it, or the angles to which it is ground. These are again dependent upon the nature of the material to be cut, the speed at which the cut is made, the depth of cut, and the rate of feed. In many shops the angles given to the tools are those determined by the experience of the workmen themselves, and skilful workmen are able to secure fairly close approximations to the proper combinations of tools angles to suit their work, but it is by no means common to find a man who can name the angles at which he aims when grinding, and still more rare to find one who is provided with any means of checking the correctness of his grinding, if he knows exactly what he wants.

All this Mr. Donaldson rightly considers as unsatisfactory, believing that the proper method is to determine the proper angles to which tools should be ground for various kinds of work, and to do the grinding altogether upon machines which will insure the accurate reproduction of the desired angles. The variation in the tool angles is always dependent on the nature and hardness of the material to be cut; this is especially the case in the cutting angles, but the influence and effect of the depth of cut and the fineness or coarseness of the feed must not be overlooked. There are indications in Mr. Donaldson's experiments that a light cut and a fine feed should be attacked with a sharper angle than would be permissible with a heavy cut and a coarse feed. Experience goes to show that if the work will stand it, a heavy cut and slow speed will be more efficient that a light cut and quick speed, even though the result should apparently be the same.

The experiments conducted by Mr. Donaldson covered fourteen qualities of material, including steel, wrought-iron, cast-iron, and certain yellow-metal alloys. Upon these were made tests with pointed roughing tools, an ingenious form of pressure dynamometer being used to determine the effect of an increase in feed upon the pressure on the point of the tool. The desirability of making such measurements will be seen when it is realised that an increase of feed from 1/32 in. to 1/20 in. increased the pressure from 80 to 150 pounds per square inch.

In the original paper the best results selected from many tests are tabulated and arranged so as to show the nature of material, speed of cut, material removed, and general performance with regard to the angles used. The best angles naturally varied according to the hardness of the material cut. For the materials classified as hard, medium hard, and very hard, the best cutting angles appear to be 59°, 62°, and 75° respectively, for speeds of 10 to 15 feet per minute. These, however, are but general conclusions, and the tables should be consulted for closer details as to angles and speeds for various materials.

As a result of the experiments, it was found practicable to take the grinding of the tools altogether out of the hands of the men in a certain shop, and to have them ground to the proper angles in the tool room and issued as required. The materials were also classified and the correct speeds for each determined, and the foreman was required to see that the work was done according to the instructions. Under such a system it is not only possible to have the maximum efficiency reached, but also to obtain a knowledge beforehand of the time required for a certain operation, thus enabling closer estimates to be made and the result checked.

It is unfortunate that the experiments so carefully conducted by Mr. Donaldson did not include a close measurement of the power required for each test, as might readily have been done had the machines been operated by independent electric motors equipped with recording wattmeters. Doubtless his work will stimulate others to undertake similar tests, and contribute further additions to the common stock of information.

In an appendix to the paper Mr. Donaldson gives some information as to tests made upon the newer high-speed steels, and although the results are given as only preliminary, they are of interest. The important point brought out is that the high-speed steel which is the best for cutting mild material is by no means certainly the best for cutting very hard material, and vice versa. It is therefore especially important to take into account the nature of the material to be cut.

The great advantage of the high-speed steels appears in the cutting of materials of moderate hardness. Thus experiments show that the new steels show speeds of work nearly ten times faster than ordinary tools when working in moderately hard material, but only about three times faster when cutting the harder qualities of material. This may be because the steel makers have directed their attention more exclusively to the demands for the quick removal of large weights of mild or medium hard material, or it may be to a lack of realisation of the necessity for special qualities for cutting very hard material.

So far as the Taylor-White steel is concerned, however, its inventors distinctly announce that it is intended solely for use on roughing cuts, for the rapid removal of large amounts of stock on wrought or cast iron.

THE CALIBRATION OF INDICATORS.

DATA AND RESULTS OF INVESTIGATIONS UPON THE SPRINGS OF STEAM ENGINE INDICATORS AT VARIOUS TEMPERATURES.

Physikalisch-Technisch-Reichsanstalt.

WE noted in these columns a few months ago the paper of Herr Roser upon the various methods of testing the accuracy of the springs of steam engine indicators, showing the methods of calibrating such springs and of correcting the diagrams. Herr Roser's paper has brought out a comparison of the methods discussed by him with those in use at the Reichsanstalt, and in a paper by Messrs. Wiebe and Schwirkus, published in the *Zeitschrift des Vereines Deutscher Ingenieure* some notes of the work of the Reichsanstalt in this line may be taken.

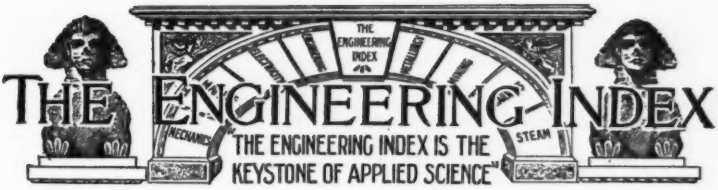
In the first place there is no doubt that the readings of the instrument are affected by the direction of movement of the piston, but it does not appear that any direct relation can be discovered. Tests of several instruments, both new and used, show variations which may well be attributed to piston friction, the variations from the mean being from 3 to 4 per cent., taken at intervals of one atmosphere (metric) throughout the whole scale. By adjusting the instrument so that the reading is correct for the middle of the pencil movement the error may be minimised, and this is desirable in all cases.

Tests under steam show results similar to those found by Bach, Slaby, and other investigators. In no case is it proper to assume that the temperature of the spring is that due to the steam pressure. If the indicator piston is very leaky, so that there is a free flow of steam past it, the temperature will approach that of the steam, but with a piston fairly tight experiments show that the temperature of the indicator spring is about 60°C. lower than that of the steam at the indicated pressure, this difference being nearly constant for pressures from 2 to 15 atmospheres. The temperature of the spring also varies at different points in the stroke, so that it is a matter which cannot well be determined in a form available for subsequent use in correction of diagrams. These facts render it difficult to make any calibration measurements of indicator springs under steam or other methods of heating, since the operative conditions cannot be exactly reproduced, and calibrations for one range of pressure and one rate of speed will not serve for another. In general it must be accepted that the temperature of the spring does not bear any direct or ascertainable relation to the mean effective steam pressure.

Tests have been made of certain forms of indicators in which the spring is placed outside the cylinder, and in such instruments the temperature of the spring is not affected to any extent which might change its action. Thus in such an instrument the application of a thermo-element for the measurement of the temperature of the spring showed a maximum of 54°C., when the surrounding air stood at 45°C.

In general, therefore, it may be accepted that there is a distinct variation between the indications of springs which are cold and those which are subjected to the action of steam, but that this difference can be determined only by testing each indicator for its own instrumental correction. While such a calibration cannot be made to cover all possible corrections it may minimise the errors very materially. It is evident, however, that the proper remedy is to remove the spring from the action of the steam, and this has already been done in several forms of instrument, and there are numerous ways in which satisfactory constructions might be imagined to accomplish this end.

The study which has given to the instrumental errors of the indicator show how absurd it is to carry out computations as to water consumption, horse-power, cylinder condensation, etc., to several decimal places when it is altogether possible that there are uncorrected errors in the diagrams amounting to more than unity in the original data. Any important work involving indicator diagrams should be accompanied with some information as to the manner in which the instrument has been calibrated if the results are to be accepted without reserve.



The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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BRIDGES.

American Bridges.

Bridge Building and Bridge Works in the United States. The first of a series of articles aiming to describe American practice in bridge design and construction, and the shop equipment and methods of American bridge works. 2500 w. Engr, Lond—Jan. 16, 1903. Serial. 1st part. No. 53086 A.

Arches.

Computations for Masonry Arches (Calcul des Ponts en Maçonnerie). H. Lossier. A review of the method of Ritter, treating of the distribution of forces in masonry bridges of several arches. 2000 w. Génie Civil—Jan. 3, 1903. No. 53214 D.

Braced Arch.

The Rio Grande Braced Arch Bridge, Pacific Ry. of Costa Rica. Illustrated detailed description of a two-hinged steel braced arch structure 685 ft. long and 340 ft. high from the rails to the water. 2000 w. Ry & Engng Rev—Jan. 24, 1903. No. 53173.

Bridge Elevation.

The Elevation of the Chicago and Alton Bridge at Bridgeport, Chicago. Illustrated description of the work of elevating a

We supply copies of these articles. See page 973.

drawbridge 11 feet from the old foundation without interrupting river or railroad traffic. 600 w. Ry Age—Jan. 23, 1903. No. 53142.

Cantilever.

The Mississippi River Bridge at Thebes. Illustrates and describes a large cantilever bridge under construction for the purpose of forming a connection between railroads. It is especially notable by reason of the nature of its approaches which are to be entirely of concrete. 2700 w. R R Gaz—Jan. 9, 1903. No. 52926.

Culverts.

Determining the Size of Railroad Culverts. S. Whinery. Discusses the elements that must enter into such a computation, and method of arriving at the proper capacity. 4000 w. R R Gaz—Dec. 26, 1902. No. 52923.

The Design and Construction of a 50-ft. Brick Arch Culvert Across Rock Creek, Washington, D. C. W. J. Douglas. An illustrated article giving the history of the work and an account of its design and construction. 5200 w. Eng News—Dec. 25, 1902. No. 52872.

Erection.

Erection of the Northwest Miramichi Bridge, Newcastle. N. B. Illustrated detailed description of the bridges of the Intercolonial Railway, which cross the branches of the Miramichi River, and of the excellent state of preservation of the bridge which is being replaced, with particulars of the erection of the new structure. 2700 w. R R Gaz—Jan. 23, 1903. No. 53171.

Girders.

The Support of the Ends of Cross Girders. Brief illustrated descriptions of methods of carrying the ends of cross girders upon the main or longitudinal girder, with critical remarks. 1900 w. Engr, Lond—Dec. 26, 1902. No. 52699 A.

India.

The Rupnarayan Bridge; Bengal-Nagpur Railway. S. Martin-Leake. Describes the construction of this bridge which consists of 7 spans of 300 ft. and 4 spans of 100 ft. 1500 w. Engng—Dec. 19, 1902. No. 52688 A.

Omaha.

The Omaha Interstate Bridge. Illustrates and describes the old and new structures of the bridge between Omaha and Council Bluffs. The new bridge is now under construction without interrupting traffic. 4300 w. Eng Rev—Jan. 24, 1903. No. 53156.

Pittsburg.

Pennsylvania Company's Bridge at Eleventh Street, Crossing the Allegheny River. Antes Snyder. A brief history of the public improvements which formerly occupied the vicinity of the recently constructed double deck bridge at this point. Discussion. Ills. 5000 w. Pro Engs Soc of W Penna—Nov., 1902. No. 53037 D.

The Monongahela Bridge. An illustrated detailed description of a double-track bridge having the longest truss span yet completed on the American Continent. Gives interesting details in methods and operations of construction. 7500 w. Eng Rev—Jan. 3, 1903. No. 52907.

Reinforced Concrete.

See Civil Engineering, Construction.

Suspension.

The Damage to the New East River Bridge Cables by Fire and the Proposed Method of Repairing it. Technical portions of the report of the Board of Engineers appointed to report in regard to the repairs needed for the partially completed bridge across the East River at New York. 2200 w. Eng News—Jan. 22, 1903. No. 53170.

The Injury to the Cables of the New East River Bridge. Isaac Harry. Also report of commission appointed to report on the condition in which the fire left the cables of the new suspension bridge across the East River at New York. 1800 w. R R Gaz—Jan. 16, 1903. No. 53059.

Viaduct.

The Viaur Viaduct (Le Viaduct Métallique du Viaur). E. Godfernaux. An illustrated description of the steel railway viaduct over the Viaur Valley near Rodez in the south of France. The clear opening of the cantilevers is 220 metres. 6000 w. 2 plates. Rev Gen des Chem de Fer—Jan., 1903. No. 53230 H.

CANALS, RIVERS & HARBORS.

Canal Haulage.

See Electrical Engineering, Power Applications.

Cauvery Falls.

See Elect. Engng., Generating Stations.

Flood Warnings.

The Flood Warning Service on the Danube and its Tributaries in Upper Austria (Vorschrift für den Hochwassernachrichten und Warnungsdienst fur die Donan und ihre Nebenflüsse in Oberoesterreich). With map showing the location of stations and very complete telegraphic connections. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 3, 1903. No. 53261 D.

Great Britain.

Harbors and Waterways in 1902. A review of works under construction, and of matters relating to the harbors and waterways. 5500 w. Engr, Lond—Jan. 2, 1903. No. 52940 A.

Irrigation.

Irrigation. From Twelfth Census. An illustrated historical review of the irrigation work in America. 9500 w. Sci Am Sup—Jan. 10, 1903. Serial. 1st part. No. 52866.

Irrigation Works of India. Brief review of the extensive irrigating works which have cost the British Government over $150,000,000. 1100 w. U S Cons Repts, No. 1554—Jan. 26, 1903. No. 53128 D.

Isthmian Canal.

An Alternative Line for the Nicaragua Canal; and a Proposed New Method of Dam Construction. Discussion of a paper by J. Francis Le Baron. Map. 10,800 w. Pro Am Soc of Civ Engrs—Dec., 1902. No. 52632 E.

Java.

The Improvement of the Outlet of the Strait of Surabaya (Over den Toegang mit Zee naar Straat Soerabaja). J. W. Welcker. A discussion of the practicability of improving the channel from the strait of Madoera to the Java Sea, with a comparison with the mouth of the Rio Grande de Sal, and the Delta of the Nile. 3500 w. De Ingenieur—Dec. 20, 1902. No. 53248 D.

Navigation.

The International Navigation Congress at Düsseldorf, 1902 (Die Verhandlungen des IX Internationalen Schiffahrts-Kongresses in Düsseldorf, 1902). A. Schromm. Opening address, outlining in general the work of the congress. Two articles. 15,000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 2, 9, 1903. No. 53225 each B.

New York Canals.

Governor Odell on the Proposed 1000 Ton Barge Canal. A portion of the Governor's message to the legislature in regard to the project for the construction of a 1000-ton barge canal from Lake Erie to the Hudson river. 1300 w. Eng News—Jan. 15, 1903. No. 53054.

Proposed Improvements in the Erie Canal. Map, with review of the different plans for improvements proposed. 1200 w. Sci Am Sup—Jan. 17, 1903. No. 53048.

Niagara.

The Canadian Niagara Power Development. Orrin E. Dunlap. An illustrated account of construction work for the hydro-electric power plant on the Canadian side of Niagara Falls. 1800 w. Elec Rev, N Y—Jan. 3, 1903. No. 52849.

Nile.

The Opening of the Assouan Dam. An illustrated account of this recently completed work, with a review of the great engineering works of Egypt, the condition of the land, etc. 3300 w. Sci Am Sup—Jan. 10, 1903. No. 52865.

Nile Irrigation Works. W. Noble Twelvetrees. The present article is devoted to the Delta and the Delta barrage. Illustrated. Serial. Part I. 3500 w. Feilden's Mag—Jan., 1903. No. 53117 B.

Review.

Bridges, Foundations, Docks and Water Fronts, and Canals. William H. Burr. Reviews the work in this field during the last quarter of a century, the advances made, etc. 3000 w. Eng Rec—Jan. 3, 1903. No. 52912.

Soulanges Canal.

Electrical Work on the Soulanges Canal. Illustrates and describes the electrical installation which operates the sluices, gates and bridges of this new canal around the rapids of the St. Lawrence. 700 w. Engr, Lond—Jan. 9, 1903. No. 53031 A.

Yazoo Delta.

The Yazoo Delta of Mississippi and Location and Construction of Its Railroads. J. N. Darling. An illustrated description of the country and the methods of railroad construction. Discussion. Map. 4700 w. Jour W Soc of Engrs—Dec., 1902. No. 52660 D.

CONSTRUCTION.

Building Construction.

Reduction of Fire Hazards in Building Construction. Perez M. Stewart and Rudolph P. Miller. Reviews the work in this field in the city of New York, presenting in detail the attitude of the Bureau of Buildings on many points of the building code, showing where improvements may be expected and the features of construction that tend to accomplish the desired results. 10,000 w. Ins Engng—Dec., 1902. No. 52627 C.

Factories.

Recent Practice in the Design, Construction and Operation of Raw Cane Sugar Factories in the Hawaiian Islands. J. N. S. Williams. An illustrated detailed description of works designed to meet the changed conditions and increase in production. 9700 w. Inst of Mech Engrs—Nov. 21, 1902. No. 52621 D.

Fire-Escapes.

Fire-Escapes in American Commercial Buildings. Charles A. Daubney. Considers points having a bearing on the safety of persons in case of fire, describing types of fire-escapes in use, and discussing their features. Gives suggestions for fire protection. Ill. 10300 w. Jour Roy Inst of Brit Archts—Dec. 6, 1902. No. 52616 F.

Fireproofing.

Testing Oven at the Underwriters'

We supply copies of these articles. See page 973.

Laboratories. Benjamin H. Glover. An illustrated description of an oven for testing various types of fire retardants used in these Chicago laboratories. 1200 w. Ins Engng—Dec., 1902. No. 52626 C.

Reinforced Concrete.

Ferro-Concrete Bridge Over the Sutton Drain, Hull. Brief illustrated description of the first bridge of this material built in England. 700 w. Engng—Jan. 2, 1903. No. 52937 A.

Loading Tests of a Reinforced Concrete Plate (Belastungsversuch an einer Armierten Betonplatte). Prof. Melan. A graphical examination of the stresses and strains in a plate of reinforced concrete, showing the importance of the proper location of the metallic reinforcement. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53221 B.

Reinforced Concrete (Der Eisenverstarkte Beton). W. Linse. The first installment of a general review of the subject, with data showing the increase in its use since 1892. Serial. Part I. 2000 w. Stahl u Eisen—Jan. 1, 1903. No. 53255 D.

Recent Experiments with Hennebique Beams at Lemberg (Neue Versuche mit Hennebiqueträgern in Lemberg). Dr. Max R. v. Thullie. Data and results of concrete beams reinforced with iron rods according to the Hennebique system. A mathematical analysis of the application of the results to future computation is appended. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 12, 1902. No. 53219 B.

Some Hints as to Reinforced Concrete Construction. Discusses the trustworthiness of this combination of steel and concrete so much used as a structural material. 1200 w. Jour Gas Lgt—Dec. 16, 1902. No. 52726 A.

The Concrete Bridge at Herkimer, N. Y., Over West Canada Creek, Now Being Constructed by the Utica & Mohawk Valley Railway Co. F. C. Phillips. Illustrated description of a viaduct for an electric railway, consisting of 10 reinforced concrete arches and 4 steel spans, 1212 feet long in all 3500 w. St Ry Rev—Dec. 20, 1902. No. 53106 C.

The Cottancin System of Reinforced Construction. Brief description of this system of steel-cored brick and steel-cored cement construction which is largely employed in France. 900 w. Arch't, Lond—Dec. 19, 1902. No. 52611 A.

Roofs.

Progress in the Design of Roof Structures Since 1850. Ewing Matheson. A short history of the improvements during the last fifty years. Ill. 3000 w. Engr, Lond—Jan. 9, 1903. No. 53027 A.

Sky-Scrapers.

The Biography of an Office Building. Arthur Goodrich. An illustrated article tracing the development of the American sky-scraper from the signing of the contract to completion. 3200 w. World's Work—Jan., 1903. No. 52629 C.

Spliced Joints.

Spliced Joints in the Columns of Steel-Frame Buildings. John Stephen Sewell. A discussion of careless work on steel-framed buildings, and improvements needed. 2400 w. Eng News—Dec. 25, 1902. No. 52874.

Structural Steel.

Structural Steel Work in the Ansonia Apartment Hotel, New York—Roof Trusses, Tower and General Construction. Begins an illustrated detailed description of the steel work in this recently completed apartment hotel in New York, which is one of the largest and most costly yet built. 3300 w. Eng Rec—Jan. 10, 1903. Serial. 1st part. No. 52970.

Tunnels.

Tunnel Construction in Chicago. George W. Jackson. Illustrates and describes the method of driving and constructing adopted so as not to disturb the surface. 3600 w. Mines & Min—Jan., 1903. No. 52-958 C.

Underpinning.

Underpinning the Philae Temples. A detailed accaunt of the work of underpinning these ancient temples in the Nile. Ill. 2400 w. Builder—Jan. 17, 1903. No. 53091 A.

MATERIALS.

Artificial Sandstone.

The Manufacture and Properties of Artificial Sandstone. Samuel V. Peppel. Abstracted from the *Trans. of the Am. Ceramic Soc.*, 1902. Describes the material, processes of manufacture, quality, and the mechanical equipment needed. 5000 w. Eng News—Jan. 22, 1903. No. 53168.

Cast-Iron.

Experiences with Cast Iron Columns in Two English Spinning Mill Fires. Gives report of these fires which seem to indicate that the destruction of the buildings was due to the breaking of the cast-iron posts. 1000 w. Eng News—Jan. 1, 1903. No. 52881.

Concrete.

Pebble Faced Bridge in the National Park, Washington, D. C. W. J. Douglas. Illustrated description of a bridge designed for special surroundings, and of the methods of construction. 1100 w. Eng News—Jan. 22, 1902. No. 53167.

Strength of Concrete with Various Aggregates. Gives tables showing the strength of concrete made of various ma-

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terials, with description of tests from which the results were derived. 1700 w. Munic Engng—Jan., 1903. No. 52649 C.

Corrosion.

Corrosion of the Steel Frames of Buildings. Charles L. Norton. An illustrated account of tests made and their results with conclusions drawn. 2000 w. Tech Quar—Dec., 1902. No. 52950 E.

Explosives.

A Safe and Economical Substitute for Dynamite. Reports the results of some tests made of Joveite. Also editorial on the safety powders destined to replace dynamite. 3300 w. Eng News—Jan. 22, 1903. No. 53169.

Glass.

Wire Glass (Le Verre Armé). Léon Appert. A complete description of the method of manufacturing plate glass with a wire netting imbedded in the mass. The product is valuable for strength, and resistance to fire. 10,000 w. 1 plate. Mem Soc Ing Civ de France—Oct., 1902. No. 53278 G.

Reinforced Concrete.

See Civil Engineering, Construction.

Stone.

Heat and Frost in the Weathering of Stone. George Barnum. An article discussing the effects of extremes of heat and cold and dissenting from views of Mr. Halbert Powers Gillette. 2000 w. Stone—Sept., 1902. No. 52640 C.

Timber.

Timber Preservation. Dr. von Shrenk. An informal general discussion mostly confined to the preservation of railway ties, the processes used and results, the kinds of wood, their decay and treatment. General discussion follows. Ill. 14300 w. Pro W Ry Club—Dec. 16, 1902. No. 52982 C.

MEASUREMENT.

Coast Survey.

The U. S. Coast and Geodetic Survey. O. H. Tittmann. Reviews the history of this undertaking, the organization, work, etc. 3800 w. Nat Geog Mag—Jan., 1903. No. 52639 C.

Geodesy.

The Russo-Swedish Expedition for Measuring an Arc of the Meridian in Spitzbergen (Les Travaux de l'Expedition Russo-Suédoise pour la Mesure d'un Arc de Meridien au Spitzberg). A. Hansky. A fully illustrated account of the expedition. An arc of 4 degrees was measured up to 80 degrees north latitude. Two articles, 8000 w. Rev Gen des Sciences—Dec. 15, 30, 1902. No. 53250 each D.

Photographic Surveying.

Photographic Surveying. J. T. McIntyre. An illustrated discussion of this method of topographical surveying, and description of the instruments used. Serial. Part I. 5000 w. Feilden's Mag—Jan., 1903. No. 53114 B.

Stereoscope.

The Use of the Stereoscope in Topography and Astronomy (De l'Emploi du Stéreoscope en Topographie et en Astronomie). Col. Laussedat. A discussion of the use of stereoscopic photography in connection with surveying and astronomy with reference to recent topographic work in Austria. 2500 w. Comptes Rendus—Jan. 5, 1903. No. 53241 D.

Surveying.

Daylight Observation of Polaris to Establish a Meridian. W. O. Owens. Gives the writer's method of establishing his meridians in broad daylight. 2800 w. Eng & Min Jour—Jan. 10, 1903. No. 52969.

The Graphical Determination of Time Azimuth and Meridian (Ueber Graphische Bestimmung der Zeit, des Azimutes, und des Meridianes). E. Dolezal. Developing a graphical method of facilitating the computations, with diagrams for practical use. Serial. Part I. 1800 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 3, 1903. No. 53235 D.

MUNICIPAL.

City Work.

City Engineering Problems. John M. Goodell. Reviews the improvements in surveying, paving, road construction, street clearing, etc. 2800 w. Eng Rec—Jan. 3, 1903. No. 52914.

Fire Extinguishing.

Fire Extinguishment in Chicago. William H. Musham. An account of the present organization of the fire department, its houses, apparatus, etc., showing that it has not kept pace with the growth of the city, and suggesting a revision of the building laws, compelling owners of high buildings to have a standpipe for each floor with proper connections. Ill. Discussion. 10300 w. Jour W Soc of Engrs—Dec., 1902. No. 52662 D.

Stationary Fire Pumps. George J. Jones. Describes a fire-fighting system recently installed in Philadelphia, the necessary water pressure being secured from a large stationary pumping plant. 1200 w. Sci Am—Jan. 24, 1903. No. 53077.

Pavements.

Employment of Belgian Sandstone for Paving. Discusses the value of this material, methods of testing, wearing qualities, etc. 3500 w. Quarry—Jan. 1, 1903. No. 52981 A.

Sewage Purification.

The Salford Sewage Works. J. Cor-

bett. Abstract of a paper before the Sanitary Inst. Congress at Manchester, Eng. An account of some of the most interesting results of sewage purification experiments. 3000 w. Engng—Dec. 26, 1902. No. 52694 A.

The Septic Tank: Its Place in the Treatment of Sewage. Leonard P. Kinnicutt. Explains the result of septic action on sewage, and the effect when used with intermittent filtration beds, considering that in most cases it is a valuable adjunct. 1700 w. Eng Rec—Jan. 3, 1903. No. 52910.

The Septic Treatment of Sewage. Benjamin H. Flynn. Reviews the operation of this system, giving details of construction. 2800 w. Munic Jour & Engr—Jan., 1903. No. 52860 C.

Sewerage.

Sewerage Work; a Twenty-five Years' Review. Rudolph Hering. Reviews the works for collecting and conveying the foul waters and those for effecting their proper disposal, showing the rapid development in America. 2600 w. Eng Rec—Jan. 3, 1903. No. 52913.

The Separate System of Sewerage. J. Gust Richert, in *The Surveyor,* London. Describes some of the advantages, disadvantages and defects of this system which is considered more expensive but more efficient. 1400 w. Ill. Munic Jour & Engr—Jan, 1903. No. 52861 C.

Sewers.

The 64th St. Sewer Tunnel and Outlet Sewer, Brooklyn, N. Y. An illustrated description of this work and information relating to it. 3800 w. Eng News—Jan. 1, 1903. No. 52879.

WATER SUPPLY.

Charges.

Apportionment of Charges for Private Fire Protection and the Means of Controlling the Supply Thereto. Report of committee and discussion. 17500 w. Jour N E Water Wks Assn—Dec., 1902. No. 52636 F.

Filtration.

The New Filtration Works in Philadelphia. J. A. Stewart. An illustrated description of the extensive works under construction, which will probably be the largest and most complete in the United States. 2000 w. Munic Engng—Jan., 1903. No. 52647 C.

The Philadelphia Filtration System. States the conditions at this city, giving an account of the early supply, and begins an illustrated description of the new system of filtration works. 2800 w. Eng Rec—Jan. 3, 1903. Serial. 1st part. No. 52921.

Ground Water.

An Artificial Underground Water Supply at Gothenburg, Sweden. Describes a unique method of developing a water supply, utilizing dangerous surface waters and a limited underground supply, and securing a naturally purified underground water. Describes the works. 2500 w. Eng News—Jan. 8, 1903. No. 52885.

Ozone.

German Ozone Waterworks. Dr. Ig. Erlwein. An illustrated description of water purifying works at Schierstein, near Wiesbaden and at Paderborn, Germany, where ozone is electrically produced from air and employed on a practical scale as a sterilizing and oxidizing agent. 1500 w. Elec Wld & Eng—Jan. 17, 1903. No. 52841.

The Sterilization of Water by Ozone upon the Siemens & Halske System. (Ueber die Abtötung Pathogener Bakterien im Wasser mittels Ozon nach dem System Siemens & Halske) Messrs. Schüder & Proskauer. A discussion of the experiments made upon the water of the river Spree, at Berlin. 2000 w. Gesundheits Ingenieur—Jan. 10, 1903. No. 53244 B.

Two German Plants for Sterilizing Water by Ozone. Illustrated description of the recently opened plants at Wiesbaden and Paderborn, which are the first German works using ozone for sterilizing drinking water on a commercial scale. 1000 w. Electro-Chem Ind—Jan., 1903. No. 53153 C.

Pipe-Coatings.

Coating of Cast-Iron Pipes. W. H. Humphreys. Reports great trouble due to contamination of water by the coating used, or its improper application, and gives opinions of manufacturers and discussion. 5800 w. Builder—Dec. 13, 1902. No. 52713 A.

Pipe Specifications.

Final Report of the Committee on Standard Specifications for Cast-Iron Pipe. Also discussion. 1600 w. Jour N. E. Water-Wks Assn—Dec., 1902. No. 52,637 F.

Pollution.

The Detection and Prevention of Underground Pollution. John Shaw. Read before the British Assn. of Water-Wks. Engrs. Discusses the pollution of springs and well supplies. 2200 w. Builder—Dec. 27, 1902. No. 52714 A.

Refrigeration.

Water. E. T. Skinkle. On the proper handling of the water supply in the manufacture of ice and in cold storage. 2300 w. Ice & Refrig—Jan., 1903. No. 52606 C.

Review.

Twenty-five Years of Water Supply Engineering. J. J. R. Croes. Reviews the conditions at the two extremes of this

period, showing the important advances made. 2700 w. Eng Rec—Jan. 3, 1903. No. 52911.

Tank.

Water Tank with Hemispherical Bottom at Washington Heights, Chicago. Brief illustrated description of a steel tank of interesting design having a capacity of 180,000 gallons. 900 w. Eng News—Dec. 25, 1902. No. 52873.

Turbidimeter.

A New Turbidimeter. Charles Anthony, Jr. Gives the methods usually employed in estimating turbidity, discussing each briefly, and explains a photometric method of measuring the amount of light absorbed by a given thickness of water; describing the instrument used. Discussion. 2800 w. Jour N. E. Water-Wks Assn—Dec, 1902. No. 52635 F.

Waste.

Report on Water Waste and the Metering of the Water Supply of Chicago. Made by John Ericson, City Engineer. 2500 w. Eng News—Jan. 8, 1903. No. 52887.

Water Waste and Its Detection. Edward S. Cole. Considers the sources of waste, the effect of meters, means of detecting waste, giving a brief description of the "Pitometer." Ill. Discussion. 8700 w. Jour W Soc of Engrs—Dec., 1902. No. 52661 D.

Water-Softening.

Water-Softening Plant at the Wilmslow (Stockport) Works. T. Molyneaux. Extracts from a paper read before the Brit. Assn. of Water-Wks. Engrs., with a summary of the discussion. Describes a plant which has a capacity of 25,000 gallons per hour, using the Archbutt-Deeley process. 3800 w. Jour Gas Lgt—Dec. 23, 1902. No. 52732 A.

MISCELLANY.

Excavation.

Rock-Cutting Machines. An illustrated description of two recent examples of ingenious machines for breaking up rock under water, which have proved their value by executing an immense amount of subaqueous excavation. 800 w. Engng—Jan. 9, 1903. No. 52999 A.

Review.

Field Construction in Civil Engineering. Frank W. Skinner. Reviews what has been accomplished in the last quarter of a century in advance of previous practice. 3500 w. Eng Rec—Jan. 3, 1903. No. 52920.

1902. A general review of the year's progress in engineering,—civil, mechanical, electrical, sanitary, etc. 24000 w. Engr, Lond—Jan. 2, 1903. No. 52944 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Disturbances on Underground Cables. W. Schönau. A brief, illustrated account of disturbances on cables connecting the submarine cables terminating at Woosung, China, with Shanghai, and the improvement effected by an "induction balance" consisting of a condenser and resistance inserted between the circuits. 400 w. Elect'n, Lond—Dec. 19, 1902. No. 52804 A.

Telephone Cables. Arthur V. Abbott, C. E. A discussion of the cost and maintenance of underground and aerial telephone cables, with diagrams. 1500 w. Elec Wld Engr—Jan. 3, 1903. No. 52826.

The Conditions Involved in Multiple Electric Conductors (Ueber die Definitionen der Elektrischen Eigenschaften von Mehrfach-Leitungssystemen). Dr. F. Breisig. A discussion of the conditions involved in using multiple conductor cables for telephone lines. 4500 w. Elektrotech Zeitschr—Dec. 25, 1902. No. 53265 B.

Fire Alarms.

The Transmission of Fire Alarms. E. B. Ellicott. An illustrated detailed description of the modern fire alarm system, especially as used in Chicago. Discussion. 8000 w. Jour W Soc of Engrs—Dec., 1902. No. 52663 D.

Pacific Cable.

Opening of the First Section of the Pacific Cable. An account of the opening of the section between San Francisco and Honolulu, with information concerning the depth, and other matters of interest. Ill. 900 w. Sci Am—Jan. 10, 1903. No. 52863.

Space Telegraphy.

Analysis of Wireless Telegraph Systems in 1902. A. Frederick Collins. An illustrated description and classification of the principal systems of wireless telegraphy. 3500 w. Elec Wld & Engr—Jan. 3, 1903. No. 52824.

A New Method of Tuning Spark-telegraphy Stations (Ueber ein Neues Verfahren zur Abstimmung Funkentelegraphischer Stationen). Count Arco. A discussion of the use of the multiplicator in connection with the Slaby-Arco system for maintaining selective communication.

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6000 w. Elektrotech Zeitschr—Jan. 1, 1903. No. 53267 B.

Experiments on Selective Wireless Telegraphy. Anders Bull. Illustrated description of a system using a series of signals consisting of a fixed number of wave impulses, succeeding each other at pre-arranged short intervals of time. 2500 w. Elect'n, Lond—Jan. 2, 1903. No. 52808 A.

Record of the Year in Wireless Telegraphy. A. Frederick Collins. A review of the important events in space telegraphy in 1902. 1500 w. Elec Rev, N Y—Jan. 10, 1903. No. 53004.

The Braun-Siemens and Halske System of Wireless Telegraphy. Frank C. Perkins. An illustrated description of the apparatus used at the Cuxhaven station, on the North Sea. 900 w. Elec Engr, Lond—Jan. 2, 1903. No. 52822 A.

The Fessenden Wireless Telegraph System. A. Frederick Collins. Illustrates and describes the essential parts of this system. 1800 w. Sci Am—Jan. 3, 1903. No. 52771.

The Present State of Wireless Telegraphy. Maurice Solomon. A review of the subject with the object of forming an estimate of how far expectations have been fulfilled and what hopes may be entertained of a future of wide utility. Ill. 2500 w. Nature—Dec. 11, 1902. No. 52601 A.

Wireless Telegraphy (Drahtlose Telegraphie). Dr. Franke. A review of the present status of wireless telegraphy in Germany, with especial reference to the Braun system. 4500 w. Glasers Annalen—Jan. 15, 1903. No. 53229 D.

Telegraph History.

Old Time Telegraph History. A review of an interesting collection of original letters and documents relating to the early history of the telegraph, recently acquired by Cornell University. 4500 w. Elec Wld & Engr—Jan. 17, 1903. No. 52840.

Telephone Central.

The New Telephone Central in Düsseldorf (Das Neue Fernsprechvermittelungsamt in Düsseldorf). H. Kehr. With illustrations of wiring, switchboard and general arrangement. 2500 w. Elektrotech Zeitschr—Jan. 8, 1903. No. 53271 B.

Telephone Lines.

The Construction of Aerial Telephone Lines. Arthur V. Abbott, C. E. An illustrated discussion of pole lines for telephone circuits. Serial. Part I. 1200 w. Elec Wld & Engr—Jan. 17, 1903. No. 53119.

Telephony.

Port Arthur and Fort William Independent Telephone Systems. Illustrated detailed description of the equipment of these exchanges recently established in Canada. 1800 w. Can Engr—Jan., 1903. No. 52851.

The Evolution of the Modern Telephone System. L. A. Lindsey. An explanation of the systems at present in use, favoring the common battery, lamp signal, multiple system for large systems. 1600 w. Elec Wld & Engr—Jan. 24, 1903. No. 53164.

DISTRIBUTION.

Conduits.

Conduit System of the Manhattan Railway. An illustrated description of the underground conduits and manholes for the electric cables of the high-tension distribution service of the New York elevated railways. 2200 w. St Ry Jour—Jan. 3, 1903. No. 53021 D.

Converters.

Behavior of Rotary Converters in Traction Installations with Stationary Accumulators. Dr. Angelo Banti. An account of the singular behavior which the converter displayed according to the kind of service to which it was devoted, and the conclusions. 2800 w. Elect'n, Lond—Jan. 16, 1903. No. 53099 A.

Fuses.

Safe and Accurate Electric Safety Fuses. Joseph Sachs. Considers their evolution, principle, operation, and application, describing devices and reporting tests. Ill. 5900 w. Jour Fr Inst—Jan., 1903. No. 52631 D.

Static Converter.

Cooper Hewitt Static Converter. An illustrated description, with curves, of an apparatus consisting of a globular vessel containing vapor, at a certain degree of attenuation, and several electrodes, which converts an alternating, or a polyphase current into a pulsating direct current. 1200 w. Elec Wld & Engr—Jan. 17, 1903. No. 52842.

Substations.

Substations of Manhattan Railway. A well-illustrated description of the construction, architecture and electrical equipment of the rotary converter substations for the elevated railway in New York. 5000 w. St Ry Jour—Jan. 3, 1903. No. 53020 D.

Also, Elec Wld & Engr—Jan. 3, 1903. No. 52832.

Wiring.

Direct Current Motor Wiring. P. C. Percy. General specifications for wires leading to direct-current motors, and full wiring tables; with diagrams. 900 w. Am Elect'n—Jan., 1903. No. 53015.

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ELECTRO-CHEMISTRY.

Accumulator.

A New Electric Accumulator. Dr. D. Tommasi. An illustrated description of a lead storage cell whose plates consist of a leaden frame containing a very large number of layers, and of an electrolyzer for the preparation of spongy lead. 600 w. Elec Rev, Lond—Jan. 2, 1903. No. 52817 A.

See also Electrical Engineering, Generating Stations.

See also Mechanical Engineering, Automobiles.

Daniell Cell.

Why the E. M. F. of the Daniell Cell Changes with the Density of the Solutions. Prof. Henry S. Carhart. A contribution to the author's studies on concentration cells. 1200 w. Electro-Chem Ind—Jan., 1903. No. 53152 C.

Electric Furnaces.

High-Temperature Electro-Chemistry. Notes on Experimental and Technical Electric Furnaces. R. S. Hutton and J. E. Petavel. Full paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Illustrated descriptions of experimental and technical electric furnaces and their commercial applications, especially some of the newer industries. 11200 w. Engng—Dec. 19, 1902. No. 52689 A.

The Electric Heat Furnace. A. Henrick Jackson. The first of a series of illustrated articles dealing with its industrial non-electrolytic uses. 2000 w. Aust Min Stand—Nov. 27, 1902. Serial. 1st part. No. 52739 B.

Electrolyte Resistance.

See Electrical Engineering, Measurement.

Equivalents.

Table of Electrochemical Equivalents and Their Derivations. Carl Hering. Probably the fullest table ever published. A complete recalculation based upon the most recent and best fundamental values. Applications of the table are illustrated by a series of typical examples. 6800 w. Electro-Chem Ind—Jan., 1903. No. 53150 C.

Ozone.

See Civil Engineering, Water Supply.

Rectifier.

The Electrolytic Rectifier. Prof. C. F. Burgess. Abstract of a paper presented before the Science Club of Wisconsin Univ., giving an account of investigations carried out in the Laboratory of Applied Electrochemistry, and the results obtained with a fused electrolyte. 2500 w. Wisconsin Engr—Dec., 1902. No. 53038 D.

Refining.

Electrolytic Refining of Gold. D. K. Tuttle. An illustrated description of the electrolytic gold refining process used in the United States Mint, in Philadelphia. Electro-Chem Ind—Jan., 1903. No. 53146 C.

Review.

Electrochemistry in the Year 1902 (Die Elektrochemie in Jahre 1902). Dr. M. Krüger. The annual review of the progress of applied electrochemistry in Europe and America. Serial, Part I. 2500 w. Elektrochem Zeitschr—Jan., 1903. No. 53274 G.

The Progress of Electro-Chemistry in 1902. George P. Scholl. A general review. 2500 w. Elec Wld & Engr—Jan. 3, 1903. No. 52828.

Smelting.

A French Plant for Making Steel in the Electric Furnace. An illustrated description of the Keller process used at Kerrousse. 2000 w. Electro-Chem Ind—Jan., 1903. No. 53148 C.

An Attempted Defence of the Electric Smelting of Iron Ores. Editorial criticizing statements made by A. J. Rossi in a paper published in the *Iron Age* of Nov. 20, 1902. 1000 w. Eng News—Jan. 8, 1903. No. 52886.

ELECTRO-PHYSICS.

Electro-Magnetism.

Electro-Magnetic Rotations. Howard B. Dailey. Illustrates and describes experiments showing the rotational features of electro-magnetism. 1300 w. Sci Am—Dec. 27, 1902. No. 52765.

Electrons.

Faraday's Law and the Theory of Electrons. Letter from Dr. H. C. Cooper. 600 w. Electro-Chem Ind—Jan., 1903. No. 53154 C.

Theories.

Electrical Theories. Dr. John Trowbridge. A review of present theories of electrical and magnetic phenomena. 800 w. Elec Rev, N Y—Jan. 10, 1903. No. 53000.

GENERATING STATIONS.

Accumulators.

Storage Batteries in Electrical Supply. Alton D. Adams. Data concerning the operation of storage batteries in a large system of electrical supply during a period of more than three years. Tables. 1200 w. Elec Wld & Engr—Dec. 27, 1902. No. 52843.

Armature Discs.

The Construction of Slotted Armature Discs (Ueber die Herstellung Genutheter Ankerblechscheiben). R. Hundhausen. Illustrated description of the special tools used by Siemens & Halske at Charlottenburg. Two articles, 4000 w. Elektrotech Zeitschr—Dec. 18, 25, 1902. No. 53264 each B.

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Bournemouth.

The Bournemouth Corporation Tramways. An illustrated description of a combined conduit and overhead trolley electric railway at Bournemouth, England. 2500 w. Elect'n, Lond—Jan. 9, 1903. No. 53120 A.

Brussels.

St. Gilles Electric Power and Luttiches Street Railway. Frank C. Perkins. An illustrated description of an electric power station near Brussels, Belgium, operated in connection with the Liége railway. 1000 w. Elec Rev, N Y—Dec. 27, 1902. No. 52846.

Burlington, Vt.

Water Power on the Winooski. Alton D. Adams. Illustration, with description of the station in which electric power is generated for the city of Burlington, Vt. 1200 w. Elec Wld & Engr—Jan. 24, 1903. No. 53162.

Cauvery Falls.

Electric Power in India. The Cauvery Falls Plant. Capt. J. H. Thomson. A well illustrated account of a great hydro-electric plant in the State of Mysore, from which energy is transmitted 92 miles to the Kolar Gold Mines. 4500 w. Cassier's Mag—Jan., 1903. No. 52800 B.

Condenser Excitation.

Excitation of Asynchronous Generators by Means of Static Condensance. A. S. McAllister. A description, with diagram, of a method of using a condenser as a source of exciting current for an asynchronous generator. 1600 w. Elec Wld & Engr—Jan. 17, 1903. No. 52838.

Costs.

Electricity Supply Works Costs in 1900 and 1901. Tables and curves, with explanatory text, which summarize data obtained by analyses of the accounts of electric stations, both municipal and company, in the United Kingdom. 2000 w. Elect'n, Lond—Jan. 2, 1903. No. 52810 A.

Dynamo Designing.

A Criticism of Present-Day Continuous-Current Designing. Fred W. Davies. A discussion of various points in the design of continuous-current dynamos and motors. 2500 w. Elec Rev, Lond—Dec. 19, 1902. No. 52812 A.

Rotating Ring with Attached Lugs. Forrest R. Jones. Considers the design of rings of electric generators with regard to tension in ring and lug bolts. 1800 w. Mach, N Y—Jan., 1903. No. 52859.

Stress on Frames of Alternating Current Generators. P. J. Frenell. Deals with the question of mechanical design for the purpose of reducing unnecessary weight and cost in the construction of large machines. 1600 w. Elec Wld & Engr—Jan. 24, 1903. No. 53163.

The Designing of Polyphase-Current Machines. David Bergman. A discussion, with curves, of various points in the design of polyphase motors and generators. 1200 w. Elec Rev, Lond—Dec. 26, 1902. No. 52813 A.

Erith.

Erith Electricity Works. An illustrated description of works employing the four-wire three-phase system of distribution. 2000 w. Elect'n, Lond—Jan. 16, 1903. No. 53098 A.

Galveston.

New Lighting and Power Plant of the Galveston City Railway Co. An illustrated description of an electric station for railway, lighting and power service, built to replace one destroyed in the great storm of September, 1900. 3000 w. St. Ry Rev —Dec. 20, 1902. No. 53102 C.

Garvin's Falls.

The Garvin's Falls Station of the Manchester Traction, Light and Power Company. W. V. Batson. Illustrated description of one of the largest hydro-electric power systems in New England. 2700 w. Eng Rec—Jan. 24, 1903. No. 53157.

Hastings.

Electricity Supply in Hastings. An illustrated description of an electric station at Hastings, England, and an account of experiments made with the Andrews "discriminating" transformer and choking coil and with other apparatus. 5000 w. Elec Rev, Lond—Dec. 26, 1902. No. 52814 A.

Some Experiments at the Hastings Electricity Works. An illustrated account of short-circuiting experiments showing the action of the Andrews "discriminating" transformer and choking coil, and of other experiments showing various apparatus and arrangements at Hastings, England. 3200 w. Elect'n, Lond—Dec. 26, 1902. No. 52806 A.

Hochfelden-Oerlikon.

See Electrical Engineering, Transmission.

Leeds.

Leeds Electric Power Station. An illustrated description of a 9000-kilowatt electric station at Leeds, England. 1000 w. Elec Rev, N Y—Jan. 3, 1903. No. 52848.

Legislation.

Swiss Laws Regulating Electric Installations (Schweizerisches Bundesgesetz betreffend die Elektrischen Schwach und Starkstromanlagen). The full text of the recent enactments of June, 1902, regulating both moderate and heavy currents. 4000 w. Elektrotech Zeitschr—Jan. 1, 1903. No. 53268 B.

We supply copies of these articles. See page 973.

Liquid Fuel.

See Mechanical Engineering, Steam Engineering.

London.

The Electricity Works of the Central Electric Supply Company. An illustrated description of a London central station generating three-phase currents at 6000 volts. 1200 w. Elect'n, Lond—Jan. 9, 1903. No. 53121 A.

Maidenhead.

Maidenhead Electricity Supply Works. An illustrated general description of a continuous-current, three-wire system lately installed at the municipal works of Maidenhead, England, near the Thames. 4000 w. Elec Engr, Lond—Dec. 19, 1902. No. 52819 A.

Middlesbrough.

300-Kilowatt Triple-Expansion Engine; Middlesbrough Electricity Works. Illustrated description of a direct-driven electric generating plant. 1200 w. Engng—Dec. 26, 1902. No. 52693 A.

Modern Practice.

Modern Tendencies in the Development and Transmission of Power. John Joseph Flather. Slightly condensed from an address at the Washington meeting of the Am. Assn. for the Adv. of Science. Discusses useless waste of power, electric power distribution in shops, speed variation with electric motors, efficiency of electric power transmission, power development with gas engines, steam turbines, etc. 4500 w. Eng News—Jan. 1, 1903. No. 52878.

Motive Power.

Steam Engine vs. Internal Combustion Engine for Electric Power Generating Plants. Frank C. Perkins. An illustrated article giving information in regard to recently erected plants where gas engines have been installed and the systems used, the Diesel oil engines, and others. 5800 w. Mod Mach—Jan., 1903. No. 52603.

New York.

The Waterside Electric Station (Station Centrale Electrique de Waterside). F. Drouin. An illustrated description of the Waterside station of the New York Edison Company with comments from a French point of view. 3000 w. 1 plate. Génie Civil—Dec. 13, 1902. No. 53205 D.

Niagara

The New Hydraulic Plant at Niagara (La Nouvelle Usine Hydro-Electrique des Chutes du Niagara). Description of the new works, with illustrations of the wheels, shaft, regulators and switchboards. 2000 w. 1 plate. Génie Civil—Jan. 3, 1903. No. 53213 D.

The New Niagara. Waldon Fawcett. Brief illustrated account of the several power plants for the development of electrical energy. 1300 w. Am Mfr—Dec. 25, 1902. No. 52746.

See also Civil Engineering, Canals, Rivers and Harbors.

Parallel Working.

The Influence of the Governor Upon the Parallel Working of Alternators (Influence des Regulateurs sur le Fonctionnement en Parallelle des Alternateurs). M. de Marchena. A discussion of the speed regulation of engines for driving alternators in parallel, with regard to the angular variations in velocity. 15,000 w. Bull Soc Int des Electriciens—Nov., 1902. No. 53260 H.

Pike's Peak.

The Water and Electric Power System of the Pike's Peak Power Co., Colorado. W. P. Hardesty. Illustrated detailed description of the development of this system, which is the first large enterprise to utilize the streams of Pike's Peak. 5000 w. Eng News—Jan. 1, 1903. No. 52877.

Portland.

See Electrical Engineering, Transmission.

Prudential Buildings.

A Large and Modern Isolated Power Plant. A well-illustrated description of the steam and electrical plant and equipment of the buildings of the Prudential Insurance Co., Newark, N. J. 4000 w. Am Elect'n—Jan., 1903. No. 53010.

Review.

Central Station Progress During 1902. W. S. Barstow. A general review of electric generating station practice. 1800 w. Elec Wld & Engr—Jan. 3, 1903. No. 52820.

Rotwein.

The Rotwein Electric Plant (Das Elektrizitatswerk in der Rotweinklamm). A description of the manner in which a mountain torrent was used to develop 850 h. p. for use in cutting the Karawanken tunnel near Assling, in Carinthia. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 3, 1903. No. 53262 D.

St. Georges.

The Distribution of Electric Energy in the Department of Aube (Distribution de l'Energie Electrique dans le Département de l'Aube). An illustrated description of the hydro-electric station at St. Georges, department of Aube, France, developing 3,200 horse power, and distributing current for a radius of 30 kilometres. Two articles, 2000 w. L'Electricien—Jan. 3, 10, 1903. No. 53283 each B.

Sault Ste. Marie.

Sault Ste. Marie and Its Industries.

Brief account of the developments on the Canadian and United States sides of the St. Mary's river. Ill. 4700 w. Can Eng—Jan., 1903. No. 52852.

Short Circuits.

Armature Reactions in Short Circuiting Polyphase Generators (Ankerreactie en Kortsluiting van Draaistromgeneratoren). A. C. van Rossem. An analytical and graphical treatment of the effects of short circuiting, discussing the methods of Behn-Eschenburg, Rothert, and Potier. 2000 w. De Ingenieur—Jan. 3, 1903. No. 53249 D.

Station Design.

Some Engineering Hints on a Tramway System. W. Dalton. A discussion of some of the chief points in the design and running of an electric railway power station, cables, electrolysis, etc. 2800 w. Elec Engr, Lond—Dec. 19, 1902. No. 52820 A.

Statistics.

Connections to Electricity Supply Works. Deductions from the large table of electric station statistics in the United Kingdom, published as a supplement, with diagrams showing the growth of business in both London and the Provinces. 600 w. Elect'n, Lond—Jan. 9, 1903. No. 53122 A.

Statistics of Electric Stations in Germany (Statistik der Elektrizitätswerke in Deutschland). The usual annual statement of the electric generating stations in Germany, with comparisons with preceding years. Also editorial. 15000 w. Elektrotech Zeitschr—Dec. 18, 1902. No. 53263 B.

Transformers.

See Electrical Engineering, Measurement.

LIGHTING.

Arc Lamps.

Light and Illumination. E. Leavenworth Elliott. Reviews the history and development of the arc lamp. 3800 w. Cent Sta —Jan., 1903. No. 52963.

Costs.

The Cost of Electric Light and Electric Light Plants to Municipalities. Comparison of data from reliable sources, particularly with reference to cities of about 50,000 population. 2000 w. Munic Engng—Jan., 1903. No. 52648 C.

Incandescent Lamps.

The Manufacture of Incandescent Lamps (Fabrication des Lampes Electriques à Incandescence). Paul Razous. A general account of the manufacture of incandescent glow lamps, including the preparation of the filament and the exhausting of the bulbs. 2000 w. Génie Civil—Dec. 20, 1902. No. 53209 D.

Interior Lighting.

Electric-Lighting Arrangements in Flats, Offices and Residences. F. J. Warden Stevens. Suggestions for the economical lighting of residential flats, offices and like buildings. 2300 w. Archt, Lond —Jan. 2, 1903. No. 52928 A.

Photometry.

See Electrical Engineering, Measurement.

Recent Progress.

Recent Lighting Progress. Henry Noel Potter. A review of the Bremer arc lamp, Cooper Hewitt vapor lamp, osmium lamp, Nernst lamp and general electric lighting progress. 2200 w. Elec Rev, N Y—Jan. 10, 1903. No. 53003.

MEASUREMENT

Dynamometer.

The Electromagnetic Absorption Dynamometer. C. Arthur Conant, and Clifton R. Hayes. Illustrated description of a novel piece of apparatus in the Electrical Laboratory of the Worcester Polytechnic Inst. 3200 w. Jour Worcester Polytechnic —Jan., 1903. No. 53133 C.

Electrolyte Resistance.

Observations on the Ohmic Resistance of Electrolytes and Its Determination. J. Wright. An illustrated discussion of the difficulties of measuring the resistance of electrolytes and of various methods for doing so. 2000 w. Elec Rev, Lond—Jan. 2, 1903. No. 52815 A.

Electrometer.

A New Capillary Electrometer. George J. Burch, F. R. S. Abstract of a paper before the Royal Society, with illustrated description of an electrical measuring instrument for laboratory use, and of the method of putting in the capillary tubes. 1000 w. Elect'n, Lond—Dec. 19, 1902. No. 52805 A.

Fault Localising.

Fault Localising on Tramway Systems. A. Johnston. An illustrated description of a method of localising faults on overhead wires, conduits and feeders of electric railway systems. 1200 w. Elec Rev, Lond—Jan. 9, 1903. No. 53123 A.

Impedance.

The Relation of Synchronous Inpedance to the Impedance at Standstill. F. Townsend, H. P. Freund, W. I. Reich. An account, with diagrams, of experiments on the impedance of several alternating-current generators. 1000 w. Elec Wld & Engr—Jan. 3, 1903. No. 52825.

Insulation Resistance.

Reducing the Measured D. R. of a Laid Submarine Cable to 75° F. and Atmospheric Pressure. J. Rymer-Jones. A dis-

cussion, with formulæ, showing that to get the true insulation resistance, a submarine cable must be considered in sections in which the conditions are uniform. 2000 w. Elec Rev, Lond—Jan. 2, 1903. No. 52818 A.

Magnetic Measurements.

Industrial Magnetic Measurements (Sur les Mesures Magnétiques Industrielles). M. Armagnat. A discussion of practical methods of determining the magnetic properties of iron in connection with the commercial manufacture of apparatus. 1200 w. Bull Soc Int des Electriciens—Nov., 1902. No. 53259 H.

Motor Diagrams.

A Graphical Discussion of the Cascade Operation of Polyphase Motors (Graphische Behandlung der Kaskadenschaltung von Drehstrommotoren). Dr. Max Bresslauer. An application of Heyland's graphical method to the analysis of the operation of motors in cascade. 5000 w. Elektrotech Zeitschr—Jan. 1, 1903. No. 53266 B.

Graphical Determination of Speed, Current, and Motor-Load from the Motor Diagram (Graphische Ermittelung von Geschwindigkeit, Stromverbrauch und Motorbelastung Elektrischer Fahrzeuge aus dem Motordiagramm). R. Mauermann. A description of the use of power, current, and velocity curves in proportioning a projected electric tramway installation. 3000 w. Elektrotech Zeitschr—Jan. 8, 1903. No. 53270 B.

Polar Diagrams of Induction Motors (Kreisdiagramm des Drehstrommotors). J. K. Sumec. An application of the polar diagram to the determination of iron losses, capacity, slip, and efficiency of induction motors. 2000 w. Zeitschr f Elektrotechnik—Jan. 4, 1903. No. 53276 D.

Three-Phase Measurements. Leslie L. Perry. Description, with diagrams, of a method for measuring the power factor of any three-phase circuit, no matter how unbalanced are the currents and voltages. 600 w. Elec Wld & Engr—Jan. 10, 1903. No. 52835.

Photometry.

Photometry for Electricians—and Others. An abstract of a paper by Dr. J. A. Fleming before the Inst. of Elec. Engrs. and of the discussion that followed. 4000 w. Jour Gas Lgt—Dec. 16, 1902. No. 52728 A.

The Photometry of Electric Lamps. Dr. J. A. Fleming. Abstract of a paper before the Institution of Electrical Engineers, considering standards; processes of measurement; heterochromic photometry; and international agreements. Illustrated. Serial. Part I. 5500 w. Elect'n, Lond—Jan. 2, 1903. No. 52811 A.

Potential.

The Determination of Differences of Potential with the Telephone as a Z ro Instrument (Die Messung von Potentialdifferenzen mittels Telephon als Messinstrument). Franz Fischer. A description of the application of the telephone to the compensation method of measuring differences of electric potential. 2000 w. Zeitschr f Elektrochemie—Jan. 1, 1903. No. 53275 G.

Quantometer.

An Electric Quantometer. R. Beattie. An illustrated description of an instrument for magnetic measurements, particularly the measurement of magnetic fluxes in dynamos. A sort of "summation" ballistic galvanometer. 2500 w. Elect'n, Lond—Dec. 26, 1902. No. 52807 A.

Transformers.

Graphical Examination of Current and Pressure in Transformers (Graphische Methode zur Ermittelung des Strom und Spannungswerte von Ungleichmassigbelasteten Drehstromtransformatoren). Aug. König. An application of the graphical method of Blanc, using the vector analysis. 6000 w. Elektrotech Zeitschr—Jan. 8, 1903. No. 53269 B.

Vector Analysis.

Phase Difference and Vector Summation. George T. Hanchett. An explanation of the application of victor analysis to alternating-current calculations. Ill. 1200 w. Cent Sta—Jan., 1903. No. 52964.

POWER APPLICATIONS.

American Motors.

American Practice in Electric Motor Construction. A very fully illustrated description of many makes of electric motors, both direct and alternating current, and their parts. 10000 w. Am Elect'n—Jan., 1903. No. 53012.

Canal Haulage.

Electrical Haulage on Canals. E. W. Marchant, D. Sc. Paper before the Manchester Section of the Institution of Electrical Engineers, illustrating and describing various systems of electric traction for canals. Serial. Part I. 2000 w. Elect'n, Lond—Jan. 2, 1903. No. 52809 A.

Centrifugal Machines.

An Electrically-Driven Centrifugal Machine. Illustrates and describes two different patterns of a new centrifugal machine of British make. 800 w. Engng—Dec. 19, 1902. No. 52685 A.

Elevators.

Electric Elevators. An illustrated review of the principal types used in Paris. Translated from *La Nature*. 2500 w. Sci Am Sup—Dec. 27, 1902. No. 52768.

We supply copies of these articles. See page 973.

Furnace Plant.

Electric Power for Blast Furnaces and Coke Ovens (Emploi de l'Electricité pour le Service des Fours à Coke et des Hauts Fourneaux). J. Bratman. Describing the electric handling machinery at Newport, near Middlesbrough, England. 2000 w. Génie Civil—Jan. 3, 1903. No. 53212 D.

Induction Motors.

Determination of Induction Motor Characteristic Curves. A. S. M'Allister. Mathematical discussion of induction motors, with formulæ, diagrams and tables. 2500 w. Am Elect'n—Jan., 1903. No. 53011.

Oerlikon Induction Motor with Four Speed Variations. Hans Behr. Description, with illustrations and diagrams, of a drum-wound induction motor, with its switches and connections. 2000 w. Elec Wld & Engr—Jan. 17, 1903. No. 52839.

Machine Driving.

Continuous Current Motors for Machine Tools. F. O. Blackwell. A description of the characteristics of the different classes of metal working tools, of the requirements of motors for operating them, of the conditions limiting the range of speed variation, and some of the methods of obtaining it with continuous current motors. 1800 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52657 D.

Electrical Distribution in the Machine Shop in 1903. Kern Dodge. A brief discussion of the application of electric motors to driving machine tools. 1200 w. Elec Wld & Engr—Jan. 3, 1903. No. 52831.

Electrical Distribution of Power in Industrial Establishments. Cecil P. Poole. The last twenty-five years really covers the history of the use of motors in factories, mills, etc. The methods are discussed. 2000 w. Eng Rec—Jan. 3, 1903. No. 52918.

The Operation of Machine Shops by Individual Electric Motors. R. T. E. Lozier. Data concerning the load factor and operation of machine shops, and a description of the advantages derived from the use of individual electric motors. Ill. 4000 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52651 D.

The Requirements of Machine Tool Operation with Special Reference to the Motor Drive. Charles Day. Extracts from a paper read before the N. Y. Elec. Soc. Considers the method of driving, the requirements to be met, the factors to be considered, and the importance of management and organization to obtain the result desired. 4000 w. Ir Age—Jan. 8, 1903. No. 52675.

Also Elec Wld & Engr—Jan. 10, 1903. No. 52836.

Mining.

Electrical Mining Notes. Sydney F. Walker. An account of instance in English coal mining operations where electrical apparatus saved money. 1500 w. Elec Rev, N. Y—Jan. 3, 1903. No. 52847.

Motor Diagrams.

See Electrical Engng., Measurement.

Ore Dressing.

See Mining and Metallurgy, Mining.

Polyphase Designing.

See Electrical Engineering, Generating Stations.

Pumping.

Economic Operation of Electric Irrigation Pumps. Aug. J. Bowie, Jr. A discussion of electric pumping stations for irrigation systems, and of irrigation systems in general. 3500 w. Elec Wld & Engr—Dec. 27, 1902. No. 52844.

Electric Pumping Plant (Installations Electriques d'Epuisement). J. Loubat. Describing the pumping plant of the Monterrad shaft of the Roche-la-Molière and Firming Company, with illustrations of the surface electric plant and the subterranean pumps. 2000 w. Revue Technique—Dec. 25, 1902. No. 53215 D.

Sale.

The Sale of Power. Robert S. Hale. Discusses questions involved in the sale of power from small plants. 3800 w. Engr, U S A—Jan. 15, 1903. No. 53140.

Series Alternating.

The Series Alternating Motor Problem. George T. Hanchett. An explanation, with diagrams, of the difficulties of operating single-phase alternating current railway motors, and the way these difficulties have been met. 2500 w. St Ry Jour—Dec. 20, 1902. No. 53017 D.

Shipyard.

The Electrical Equipment of a Modern Shipyard. An illustrated description of the electrical generating and driving equipment of the plant of the New York Shipbuilding Co., at Camden, N. J. 2200 w. Elec Rev, N Y—Jan. 17, 1903. No. 53009.

Speed Control.

A Series-Parallel System of Speed Control. George W. Fowler. A description of the parts of a system including a double commutator motor, switchboard controller, automatic switches and emergency switches. Ill. 1500 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52655 D.

Discussion of Papers on Speed Control of Electric Motors. 5800 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52658 D.

Electrically Operated Coal Hoist Hav-

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ing Variable Speed Control. P. O. Keilholtz. Illustrated description and data concerning the operation. 500 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52654 D.

Multiple Unit, Voltage Speed Control for Trunk Line Service. H. Ward Leonard. A description of a single phase, high tension, alternating current system for operating trunk line railways. Conversion takes place on each locomotive and substations are eliminated. Ill. 1200 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52656 D.

The Storage Battery as a Factor in Speed Control. H. B. Coho. A description of the use of storage batteries in connection with the operation of printing presses and with the multiple voltage system. 800 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52653 D.

Three-Wire System for Variable Speed Motor Work. N. W. Storer. A description of the operation of variable speed d. c. motors on the three-wire system. Ill. 2500 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52652 D.

Variable Speed Motor Control. Charles F. Scott. Introductory address at a meeting where most of the papers were on this subject. 1300 w. Trans Am Inst. of Elec Engrs—Dec., 1902. No. 52650 D.

Steel Works.

Electrical Equipment of the Antwerp Steel Works. An illustrated description of these large iron and steel works, which will require 30,000 horse power to operate them, electric motor driving being employed throughout. 1600 w. Feilden's Mag—Jan., 1903. No. 53115 B.

Sugar Factory.

Electric Power Transmission in a Cube Sugar Factory. An illustrated description of the application of electric driving in a cube sugar factory in Bohemia. 1800 w. Elec Rev, Lond—Jan. 9, 1903. No. 53124 A.

TRANSMISSION.

High Voltage.

Evolution in High-Voltage Transmission. Charles F. Scott. A general sketch of the advance that has been made to present practice. 1600 w. Elec Rev, N Y—Jan. 10, 1903. No. 53002.

Hochfelden-Oerlikon.

The First Three-Phase Power Transmission Plant in Europe Operating at 30,000 Volts. Dr. H. Behn-Eschenburg. A well-illustrated description of power house and transmission line, and experience in operation of the power transmission from Hochfelden to Oerlikon, Switzerland. 5000 w. Elec Wld & Engr—Jan. 3, 1903. No. 52823.

Manchester, N. H.

See Electrical Engineering, Generating Stations.

Pole Lines.

Pole Lines for Power Transmission. Alton D. Adams. A description of the poles and wires of some of the principal long-distance, high-tension electric transmission lines in the United States. Serial, 2 parts. 4000 w. Elec Rev, N Y—Jan. 10 and 17, 1903. No. 53006.

Portland.

Electrical Supply from Water Power at Portland, Me. Alton D. Adams. Illustrated description of a hydro-electric plant at Great Falls, on the Presumpscot River, the outlet of Sebago Lake, Maine, and the transmission line to Portland. 2400 w. Elec Wld & Engr—Jan. 10, 1903. No. 52833.

Potential Variations.

The Variation of Potential Along a Wire Transmitting Electric Waves. C. A. Chant. Reviews briefly experiments made by investigators of these "wire-waves," giving description of recent experiments made and their results. Ill. 4000 w. Am Jour of Science—Jan., 1903. No. 52638 D.

Resonance.

Resonance Phenomena in Long Distance Transmission (Resonanzerscheinungen in Fernleitungen). W. Blanck. A mathematical investigation of the relations between resonance and length of line in power transmissions. 1000 w. Zeitschr f Elektrotechnik—Jan. 4, 1903. No. 53277 D.

MISCELLANY.

Electrical Advances.

The Relation of Electrical and Civil Engineering. Thomas Commerford Martin. Indicates some of the relationships that have developed during the last quarter of a century, the advances made, etc. 2800 w. Eng Rec—Jan. 3, 1903. No. 52919.

Europe.

A Review of Electrical Engineering in Europe During 1902. A. Webster. A general review. 3500 w. Elec Rev, N Y—Jan. 10, 1903. No. 53007.

Railway Signaling.

See Railway Engineering, Permanent Way.

Review.

The Progress of Electrical Science During the Year 1902. A. E. Kennelly. A general review. 2200 w. Elec Wld & Engr—Jan. 3, 1903. No. 52827.

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GAS WORKS ENGINEERING

Acetylene.

Purification of Acetylene. Abstract of articles by Herr G. Keppeler published in *Journal für Gasbeleuchtung.* Investigations of the value of purifying materials. Heratol is said to be the most perfect in its action. 1800 w. Jour Gas Lgt—Dec. 30, 1902. No. 52934 A.

Alcohol.

Lighting by Alcohol. Abstract of a communication presented by M. Arachequesne at a meeting of the Sociéte des Ingénieurs Civils de France. Gives illustrated descriptions of appliances for burning alcohol, and the conclusions. 2000 w. Jour Gas Lgt—Jan. 13, 1903. No. 53096 A.

Burners.

Care and Maintenance of Incandescent Gas Burners. McDougald Dexter. Showing that these burners need expert attention, and urging the gas companies to assume their adjustment and maintenance. 2500 w. Gas Engrs' Mag—Dec. 10, 1902. No. 52617 A.

Charging.

A Combined Charging and Drawing Machine. An illustrated description of an improved machine, invented by John West, for economy in retort-house labor. 4800 w. Jour Gas Lgt—Dec. 16, 1902. No. 52727 A.

Cyanide.

The Gas Industry and the Manufacture of Cyanide. An abstract translation of an article by M. M. Robnie and Leuglen in the *Revue Générale de Chimie Pure et Appliquée.* Deals with the extraction of cyanides as bye-products in the manufacture of gas. 2500 w. Jour Gas Lgt—Jan. 6, 1903. No. 52991 A.

Factories.

The Lighting of Factories. J. H. Brearley. Read before the Manchester Dist. Assn. of Gas Engrs. Aims to show that not only can gas lighting maintain its ground in this field, but there is reason to hope that it may regain some of the ground lost. 4400 w. Jour Gas Lgt—Dec. 9, 1902. No. 52723 A.

Gas-Fires.

The Choice of Gas Fires. Thomas Fletcher. Defending gas fires and stating some of their advantages. 900 w. Jour Gas Lgt—Dec. 23, 1902. No. 52730 A.

Gas Power.

See Mechanical Engineering, Special Motors.

Gas Works.

New Gas-Works at Blackpool. Brief illustrated description of works erected to meet the increased demand for gas. 1200 w. Jour Gas Lgt—Dec. 23, 1902. No. 52731 A.

The Granton Works of the Edinburgh and Leith Gas Commissioners. Walter Ralph Herring. An illustrated description with two plates, one showing the method of surveying the site and giving several sections, the other giving a plan of the works so far as they at present exist with future sections outlined, and the drainage system. 3800 w. Jour Gas Lgt—Jan. 6, 1903. No. 52989 A.

Illuminants.

The future of Coal Gas and Allied Illuminants. Prof. Vivian B. Lewis. The first of a series of lectures showing the changes in conditons during the last twenty years, and the direction in which they tend. 7000 w. Jour Soc of Arts—Dec. 26, 1902. Serial. 1st part. No. 52600 A.

Incandescence.

Experiences of Incandescent Street Lighting at Formby. J. H. Buckley. Read before the Manchester Dist. Inst. of Gas Engrs. An explanation of the methods adopted and the causes of the high average of renewals, with the writer's opinion of what is required to make incandescent street-lighting a success. 1400 w. Jour Gas Lgt—Dec. 9, 1902. No. 52724 A.

Some Notes on Several Types of Mantles for Incandescent Gas Burners. William Lincoln Smith. An account of a series of tests made upon a number of styles of mantels to determine their characteristics. 4000 w. Tech Quar—Dec., 1902. No. 52951 E.

Inclined Retorts.

An English Inclined Retort Installation in Italy. Illustrates and describes a large installation lately completed at the Milan Gas Works, with an account of the work of construction and information of interest. 3400 w. Jour Gas Lgt—Jan. 13, 1903. No. 53095 A.

An Inclined Retort-House and Its Working at Bristol. An illustrated description of a recently installed plant where the working is as completely mechanical as possible, giving costs and information of interest. 4300 w. Jour Gas Lgt—Jan. 6, 1903. No. 52990 A.

Lamps.

The Lucas Lamps. Summary of a paper

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by Dr. H. Lux, published in the *Zeitschrift für Beleuchtungswesen*. Briefly describes this lamp, which aims to get the fullest amount of light from gas, without the aid of extraneous appliances. Describes tests and gives conclusions. 1000 w. Gas Wld—Dec. 27, 1902. No. 52736 A.

Natural Gas.

Kansas Natural Gas ,Its Control and Distribution. Prof. W. R. Crane. Illutrated description of the method employed in burning it and in measuring the pressures. 4400 w. Mines & Min—Jan., 1903. No. 52957 C.

Natural Gas in England. From the *Statist*. Report of a visit to Heathfield and a discussion of the possibilities of English natural gas. 2500 w. Gas Engrs' Mag—Dec. 10, 1902. No. 52618 A.

Photometry.

Measurement of Illumination. Summary of a paper by Dr. Hugo Krüss, published in the *Journal für Gasbeleuchtung*. Illustrated discussion of the apparatus invented by Herr Anton Wingen, called an "illumination tester." 1400 w. Gas Wld—Dec. 20, 1902. No. 52735 A.

Notes on Working with an Illumination Photometer. Henry Fowler. Read at Manchester Dist. Inst. of Gas Engrs. Describes methods used by the writer, giving results of tests. 2400 w. Jour Gas Lgt—Dec. 9, 1902. No. 52725 A.

See Electrical Engng., Measurement.

Purification.

Gas Purification and Gas Purifiers. Pierre Plantinga. Discusses the capacity, arrangement, and construction of purifiers; purifying material, &c. Ill. 2000 w. Am Gas Lgt Jour—Jan. 19, 1903. No. 53062.

The Purification of Blast Furnace Gas. The first of a series of articles describing apparatus for purifying this gas. 1600 w. Ir & Coal Trds Rev—Jan. 9, 1903. Serial. 1st part. No. 53034 A.

Tanks.

A New Method of Constructing Tanks. Arthur Vye-Parminter. An illustrated description of the Cottincin system as applied to gas holder construction. 1000 w. Jour Gas Lgt—Dec. 9, 1902. No. 52721 A.

Waste.

Leakage or Preventable Waste. C. E. Jones. A discussion of the losses, charged to unaccounted-for gas, giving a table showing the percentage in 438 undertakings in the United Kingdom. 1000 w. Jour Gas Lgt—Dec. 9, 1902. No. 52722 A.

Water Gas.

Introduction of Water Gas into Coal-Gas Retorts. Abstract translation of an interesting paper by Herr C. Borchardt, published in the *Journal für Gasbeleuchtung*. 800 w. Jour Gas Lgt—Dec. 16, 1902. No. 52729 A.

INDUSTRIAL ECONOMY

Agriculture.

Agricultural Engineering. Elwood Mead. Abstract of a paper before the Am. Assn. for the Adv. of Science. Showing the relation of engineering to the growth and prosperity of agriculture, and urging that schools of instruction be establshed. 2200 w. Eng News—Jan. 15, 1903. No. 53051.

Alaska.

The Opening of the Territory of Alaska. Harrington Emerson. An illustrated review of the mining and agricultural possibilities of Alaska and the development possible with the arrival of adequate transportation facilities. 3500 w. Engineering Magazine—February, 1903. No. 53287 B.

Coal Trade.

The Coal Trade for 1902. A general review by districts of the coal trade of Great Britain. 17500 w. Col Guard—Jan. 2, 1903. No. 52946 A.

Cost Keeping.

Cost Finding Methods for Moderate-Sized Shops. H. L. Arnold. A description of the system in practical use at the Cottrell printing press works, Westerly, R. I. 3500 w. Engineering Magazine—February, 1903. No. 53290 B.

Education.

The Training of an Engineer, or the Work of Students in a Technical School. Prof W. F. M. Goss. An interesting discourse on the education and work of an accomplished engineer. Ill. Discussion. 6300 w. Pro St. Louis Ry Club—Dec. 12, 1902. No. 52620.

Eight-Hours' Day.

Eight Hours (Bank to Bank). An exhaustive statement of the employers' position in regard to the Bill before the British Parliament, at a meeting of the coalowners with representatives of the Miners' Federation of Great Britain. 3800 w. Col Guard—Dec. 12, 1902. No. 52678 A.

Employers.

Moral Responsibility of Employers. Brief particulars of what the great firm

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of Krupp have done for their employees. 900 w. Jour Gas Lgt—Dec. 9, 1902. No. 52720 A.

Factory Management.

The Commercial Management of Factories. Ian Andrews. An analytical discussion of the relations of the office manager to the works, reviewing the conditions which affect the commercial success of manufcturing enterprises. 3000 w. Engineering Magazine—Feb., 1903. No. 53292 B.

Industrial Development.

The Tendency of Enterprise. Editorial discussion of an address of Mr. George Westinghouse, to the shareholders of the British Westinghouse Company. 2500 w. Engng—Dec. 19, 1902. No. 52686 A.

Iron Trade.

The Chicago Iron Trade in 1902. W. T. Partridge. A review of the year, the new enterprises developed, the outlook for the coming year, and subjects of related interest. 15000 w. Ir Age—Jan. 1, 1903. No. 52668.

The Philadelphia Iron Trade. Thomas Hobson. A review of the past year, discussing features of interest. 3700 w. Ir Age—Jan. 1, 1903. No. 52672.

The Pittsburg Iron Trade in 1902. Robert A. Walker. General review of conditions, new construction, finished material, prices, &c. 9700 w. Ir Age—Jan. 1, 1903. No. 52671.

Labor Laws.

New Zealand Labor Laws. A summary of the "industrial conciliation and arbitration act of 1900," with explanatory notes. 11500 w. U. S. Cons Repts. No. 1538—Jan. 7, 1903. No. 52622 D.

Municipal Ownership.

Success of Municipal Ownership in Great Britain. Robert Donald. A criticism of statements made by Mr. Robert P. Porter, and presentation of statistics to show the success of the present municipal ownership movement in Great Britain. Serial. 2 parts. 12000 w. St Ry Jour —Jan. 3 and 10, 1903. No. 53100 each D.

Pension Plan.

Pension Plan of the Canadian Pacific. Rules and regulations of a system put in operation Jan. 1, 1903, showing how it differs from those of American companies. 1600 w. Ry Age—Dec. 19, 1902. No. 52752.

Profit Sharing.

One Way to Cure the Trusts. Editorial discussion of the plan of the United States Steel Corporation devised to induce officers and employees to become stockholders. 1700 w. R R Gaz—Jan. 9, 1903. No. 52927.

United States Steel to Share Profits. A copy of the circulars to stockholders and employees setting forth the plan. 4500 w. Ir Age—Jan. 8, 1903. No. 52676.

Tariff.

The New German Tariff Law. (Das Neue Zolltarif-Gesetz). The full text of the new German tariff law, with note showing its bearing upon the iron and steel trade. 2500 w. Stahl u Eisen—Jan. 1, 1903. No. 53258 D.

Trusts.

Industrial Trusts. Prof. W. Smart. Discusses the economy and monopoly of trusts as the good and bad features, showing their tendency to eliminate all unnecessary expenses in the production and distribution of goods, and also their power over price, improvements and labor. General discussion. 9500 w. Jour Soc of Arts —Jan. 16, 1903. No. 53143 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Comparison of the Battleships of the World. Gives a diagram, prepared in the Bureau of Naval Intelligence for the purpose of giving a graphic representation of the comparative homogeneity of the different classes of battleships of the principal naval powers. 1000 w. Sci Am Sup—Jan. 17, 1903. No. 53047.

The Battleships of the Future. Lewis Nixon. Discusses probable changes, the influence of the submarine boat, &c. 2700 w. World's Work—Jan., 1903. No. 52630 C.

The Chilian Battleship "Libertad." Gives the general dimensions of the vessel; its armor and armament, and illustrated description of the engines. 1100 w. Engng —Jan. 16, 1903. No. 53082 A.

The New German Battleships "H" and "J." Illustrated description of battleships of a modified Wittelsbach type, with comments. 1500 w. Engr, Lond—Dec. 19, 1902. No. 52697 A.

The Reconstructed Turkish Battleship Messoudiyeh. Illustration and brief description of an old battleship converted into an armored cruiser. 500 w. Engr, Lond—Jan. 16, 1903. No. 53087 A.

Warship Building in 1902. A review of the work of the British Navy for the year just ended. 5200 w. Engng—Dec. 19, and 26, 1902. Serial. 2 parts. No. 52687 each A.

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Boats.

The Construction of Small Sail Boats for Inland Waters. (Mittheilungen über den Bau Kleiner Segelboote für Binnenseen) W. E. Ernst. With diagrams of stability and lines of hull construction. 6000 w. Zeitschr d Oesterr Ing u Arch Ver —Dec. 12, 1902. No. 53218 B.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

Naval Officers. Memorandum dealing with the entry, training, and employment of officers and men of the Royal Navy and of the Royal Marines. Also editorial. 15500 w. Engng—Jan. 2, 1903. No. 52939 A.

The New Admiralty Scheme. Carlyon Bellairs. A discussion of the coming changes in the Royal Navy and Royal Marines. 2000 w. Engr, Lond—Jan. 2, 1903. No. 52942 A.

Cruisers.

The New Armored Cruisers "Tennessee" and "Washington." Illustrations and descriptions of these vessels and their armament. 1600 w. Sci Am—Dec. 27, 1902. No. 52766.

The Novik, the Swiftest Cruiser in the World (Nowik, der Schnellste Kreuzer der Welt). Illustrated description of the 3000 ton cruiser built by Schichau for the Russian government, and which has made a trial speed of 26 knots on a 6 hour run and 27 knots on a measured mile. 1200 w. Schiffbau—Jan. 8, 1903. No. 53246 D.

Electric Power.

See Electrical Engineering, Power Applications.

Explosion.

Explosion on Oil-Tank Steamer Progresso. An illustrated account of the terrible accident at San Francisco, on Dec. 4, which caused great loss of life and total destruction of this vessel. 1400 w. Marine Engng—Jan., 1903. No. 52789 C.

Fuel Oil.

Memoranda Regarding Fuel Oil Aboard Ship. Walter J. Goodenough. Suggestions relating to bunkers, ventilation, piping, electric light, and furnace construction. 2500 w. Marine Engng—Jan., 1903. No. 52790 C.

Governors.

See Mechanical Engineering, Steam Engineering.

Gun Distribution.

The Distribution of Guns in Battleships. John Leyland. A discussion of the armament of battleships, with plans of some of the latest vessels of this class. 4000 w. Page's Mag—Jan., 1903. No. 53109 B.

The Gun-Power of Battleships. A comparison of the new battleship built for the Chilian Navy with others of approximately the same size, with a view of showing the armament, the principal protection and the speed given for the displacement tonnage allowed. 2000 w. Engng—Jan. 9, 1903. No. 53025 A.

Japan.

Dockyard and Engine Works at Nagasaki. Illustrated detailed description of these docks and shipbuilding works, with interesting information concerning this port. 1500 w. Engng—Jan. 9, 1903. No. 52998 A.

Launches.

The Design of Motor Launches. W. F. Durand. Considers briefly the design of form and of its relation to resistance, stability, capacity, and safety. 7500 w. Marine Engng—Jan., 1903. No. 52792 C.

Navipendulum.

The Navipendular Method of Experiment as Applied to Some Warships of Different Classes. (Il Methodo degli esperimenti Navipendulari Applicato ad Alcune Navi da Guerra). G. Russo. The full Italian text of the author's paper presented in English at the meeting of the Institution of Naval Architects in March, 1902. 10000 w. 3 plates. Rivista Marittima—Dec., 1902. No. 53282 H.

Navy Yard.

Developing a British War Post. Archibald S. Hurd. A well-illustrated account of the construction of basins, drydocks, etc., in the Keyham dockyard, at Devonport, England. 2500 w. Cassiers Mag—Jan. 1903. No. 52802 B.

Penobscot River.

Steamboating on the Penobscot. A review of the boats navigating this river; the first appearing on May 26, 1824. 3700 w. Marine Rev—Dec. 25, 1902. No. 52764.

Projectiles.

Capped and Uncapped Propectiles. Illustrations showing the effect of the impact of capped and uncapped projectiles with particulars of the test. 900 w. Engr, Lond—Jan. 2, 1903. No. 52945 A.

Resistance.

Experiments upon the Resistance of a Screw Steamboat. (Versuche mit einem Schraubendampfer hinsichtlich des Widerstandes im Freien Wasser). H. Enno van Gelder. Data and results of dock trials of a steamboat at Kinderdyk, near Rotterdam. Two articles. 4000 w. 1 Plate. Schiffbau—Dec. 23,1902. No. 53245 each D.

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River Plate.

Navigation of the Rio de la Plata. Information concerning the type of vessels needed, and the points of difficulty on the river. 600 w. U S Cons Repts, No. 1530—Dec. 27, 1902. No. 52623 D.

Salvage.

Modern Methods of Saving Ships. Morgan Robertson. An illustrated article showing how new inventions have made successful difficult wrecking operations. 2000 w. World's Work—Jan., 1903. No. 52628 C.

Schooners.

Fore and Aft Schooners. Theodore Lucas. An illustrated discussion of this type of vessel which has proved itself easier and cheaper to handle than the square rig. 1700 w. Naut Gaz—Jan. 1, 1903. No. 52776.

Shipbuilding.

German Shipbuilding Progress on the Weser. Briefly reviews the recent progress in size, number, speed and comfort of German ships, and the shipyards where they are built. 1200 w. U S Cons Repts, No. 1556—Jan. 28, 1903. No. 53155 D.

The New York Shipbuilding Company's Plant, Camden, N. J. Begins an illustrated description of a modern plant equipped for the construction of modern steel commercial and battleships. 3000 w. Eng Rec—Jan. 3, 1903. Serial, 1st part. No. 52909.

Ship Yards.

How to Plan, Organize and Operate a Modern Shipyard. Theodore Lucas. Discusses the organization, and ship-yard draughting rooms, and the general superintendence. 7500 w. Naut Gaz—Jan. 1, 1903. No. 52777.

Sighting Device.

The Grenfell Sighting and Signalling Gear. Illustrates and describes a sighting device and signalling gear for diminishing the duty demanded of the gunner, especially adapted to naval ordnance. 1600 w. Engng—Jan. 16, 1903. No. 53081 A.

Steamers.

Atlantic Transport Steamers Missouri and Maine. Description and plans of vessels under construction, and their engines. 1700 w. Marine Engng--Jan., 1903. No. 52793 C.

Great Eastern Railway Company's Steamer Brussels. Illustrates and describes this vessel which represents the latest practice in channel steamers. 2000 w. Engr, Lond—Jan. 9, 1903. No. 53028 A.

Reconstruction of the Steamship "New York." Illustrations and particulars of interesting reconstruction work. 900 w. Sci Am—Jan. 17, 1903. No. 53046.

Submarines.

Submarine Boats in the United States. Remarks on the official returns of the naval Board of Inspection in regard to the official trials of the Adder and Moccasin. 2000 w. Engr, Lond—Dec. 19, 1902. No. 52695 A.

The French Submarines. A critical editorial discussion of the types thus far tried and the French manœuvres. 3700 w. Engng—Jan. 9, 1903. No. 52996 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

Accumulators for Automobiles at the Düsseldorf Exposition (Die Akkumulatores für Elektromobilen auf der Austellung zu Düsseldorf). Hans Dominik. Giving details of the principal storage batteries used for electric vehicles in Germany and exhibited at Düsseldorf. 2500 w. Elektrochemische Zeitschr—Dec., 1902. No. 53273 G.

Electric Vehicles.

Design for an Electric Runabout. J. C. Brocksmith, M. E. A complete design for vehicle, motors and battery, with many illustrations. 4000 w. Am Elect'n—Jan. 1903. No. 53013.

Present Status of Electric Automobilism. Hayden Eames. An illustrated discussion of the advantages of electric delivery wagons, and a comparison with delivery wagons pulled by horses. 1200 w. Elec Wld & Engr—Jan. 10, 1902. No. 52834.

Exhibition.

The Madison Square Garden Show. An illustrated article describing this very successful exhibition, some of the exhibits, the steam vehicles, the electric vehicles, etc. 9500 w. Horseless Age—Jan. 21, 1903. No. 53135.

Flash Generators.

The Action of Flash Generators in Use on a Motor Car. J. S. V. Bickford. A critical examination of their action and the points that affect their efficiency. 3000 w. Horseless Age—Dec. 24, 1902. No. 52748.

France.

Motor Car Developments in France. A review of the progress during the year, as shown in the vehicles on exhibition at the

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Paris show of motor vehicles, with remarks on features of interest. Ill. 2000 w. Engr, Lond—Dec. 19, 1902. Serial. 1st part. No. 52696 A.

Ignition.

Features and Failures of Ignition. Reginald Wales. On the troubles with batteries, sustaining rods and induction coils. Ill. 2000 w. Auto Mag—Jan., 1903. No. 52646 C.

Magneto-Electric Ignition. L. Baudry de Saunier. From *La Locomotive*. A practical analysis of the peculiarities of such ignition, explaining how these machines operate, and the advantages. Ill. 2000 w. Auto Topics—Dec. 20, 1902. Serial. 1st part. No. 52614.

Indicators.

The M'Innes-Dobbie Indicator and Mathot Recorder. Shows the advantage of obtaining accurate indicator diagrams from automobile engines and gives illustrated descriptions of the instruments named. 3000 w. Auto Jour—Dec. 27, 1902. No. 52711 A.

Light-Weight.

Leading Types of 1902. French Light-Weight Automobiles. Illustrates and describes some of the cars that have found favor during the last year. 2000 w. Sci Am—Dec. 27, 1902. No. 52767.

Municipal Wagons.

Municipal Motor Wagons. Archibald Sharp. Read at the Sanitary Inst. Cong., Manchester, England. On the types of vehicles for municipal service, such as the collection of refuse, water sprinkling, street sweeping, removal of snow, etc., their cost and advantages. Ill. 4400 w. Mech Engr—Dec. 27, 1902. No. 52738 A.

New Model.

Winton 1903 Model. An illustrated description of a 20 h. p. machine and its equipment. 2800 w. Auto Topics. Dec. 27, 1902. No. 52625.

Packard Car.

The Packard 12-Horse Power Car. Herbert L. Towle. Illustrated description of this machine. 2800 w. Automobile—Jan. 17, 1903. No. 53061.

Paris Salon.

An American Impression of the Paris Show. Joseph Tracy. Notes the features that impressed the writer in the machines exhibited. 1800 w. Horseless Age—Dec. 31, 1902. No. 52749.

The Annual A. C. F. Show in Paris. An illustrated report of exhibits and matters of interest. 7800 w. Auto Jour—Dec. 20, 1902. Serial. 1st part. No. 52710 A.

The Paris Autocar Show. An illustrated description of exhibits, special features, and matters of interest. 13700 w. Autocar—Dec. 20, 1902. No. 52717 A.

The Paris Salon in Text and Pictures. An illustrated account of things and incidents which bear upon the development of automobilism in the United States or illustrate the condition of the movement in France. 3500 w. Automobile—Jan. 3, 1903. No. 52602.

Petrol Car.

The Lanchester Motor Car. Illustrated detailed description of a new gasoline vehicle having characteristic features of interest. 3000 w. Engng—Jan. 16, 1903. No. 53080 A.

The Pipe Petrol Car. An illustrated detailed description of a recent vehicle manufactured in Brussels. 1800 w. Auto Jour—Dec. 20, 1902. No. 52709 A.

The Velox 12-H. P. Petrol Car. Begins an illustrated detailed description of an English car of recent design. 2400 w. Auto Jour—Jan. 10, 1903. Serial. 1st part. No. 52986 A.

The Wartburg Light Petrol Cars. Illustrated descriptions of two private cars of strong construction with twin-cylinder engines. 2800 w. Auto Jour—Jan. 3, 1903. No. 52933 A.

Petrol Motor.

The Internal Combustion Engine. An illustrated explanation of the principles of the petrol motor. 1600 w. Autocar—Dec. 27, 1902. No. 52718 A.

Power Truck.

A New Power Truck. Illustrates and describes the Morgan motor trucks and gives comparison of the cost of haulage by horses and by motor trucks. 2500 w. Ir Trd Rev—Dec. 25, 1902. No. 52856.

Speed Gearing.

The De Dion-Bouton Three-Speed Gear. Lettered drawings, illustrations and description of this method of obtaining three forward speeds and a reverse. 1200 w. Autocar—Dec. 13, 1902. No. 52716 A.

Steam Lurrey.

A Simpson and Bibby Steam Lurrey for West Africa. Illustration and description of a 5-ton steam wagon to be used for transporting mining material between the coast and gold fields. 600 w. Auto Jour—Dec. 13, 1902. No. 52708 A.

Steam Vehicles.

Present Status of Steam Vehicles. Hugh Dolnar. An illustrated review of the use of the steam engine for wagon driving, considering it the most suitable motive agent now before the public. 2000 w. Automobile—Jan. 24, 1903. No. 53145.

The Prescott Steam Carriage. Herbert L. Towle. Illustrated description of a ve-

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hicle representative of present practice in American steam carriages. 2300 w. Automobile—Jan. 10, 1903. No. 52965.

Voiturette.

The 6-H. P. De Dion-Bouton Voiturette. An illustrated detailed description of a recent light car. 900 w. Autocar—Dec. 27, 1902. No. 52719 A.

HYDRAULICS.

Electric Pumping.

See Electrical Engineering. Power Applications.

Governors.

The Governing of Water Powers. Allan V. Garratt. Reviews in a general way the most significant improvements made in governing water-wheels and the present possibilities of their regulation. 2800 w. Engr, U S A—Jan. 1, 1903. No. 52977.

Hydraulic Machinery.

Hydraulic Machinery for an Indian Locomotive Works. Illustrations and descriptions of a locomotive wheel press and a spring-testing machine, both supplied with special electrically-driven pumps. 600 w. Engr, Lond—Jan. 2, 1903. No. 52943 A.

Pipes.

Calculations for Pipes and Fittings (Calculs des Parois et Armatures des Tuyaux). C. Birault. A study of the stresses upon pipes laid upon the ground considering both the weight of the empty pipe and the effect of its contents. Two articles. 4000 w. Génie Civil—Dec. 13, 20, 1902. No. 53206 each D.

Plumbing.

Piping a Double Boiler. An illustrated description of a vertical boiler and its attendant piping with an account of the work done. 1400 w. Met Work—Jan. 3, 1903. No. 52608.

Progress.

Progress in Hydraulic Power Development. J. T. Fanning. Reviews the development, especially the achievements of the last twenty-five years. 3300 w. Eng Rec—Jan. 3, 1903. No. 52915.

Water Power.

The Development of Mountain Water Powers. Paul Letheule. An illustrated description of the hydraulic power possibilities of the French Alps, and an account of the developments in the district about Grenoble. 4000 w. Engineering Magazine—February, 1903. No. 53288 B.

The White Coal Congress (Congrès de la Houille Blanche). Ch. Pinal. A full account of the proceedings of the congress which investigated the water power available in the French Alps. 15000 w. Mem Soc Ing Civ de France—Nov., 1902. No. 53281 G.

Water Power Development. W. F. Durand. Briefly considers the important features of hydro-electric power plants as applied to modern installations 5800 w. Engr, U S A—Jan. 1, 1903. No. 52976.

See also Electrical Engineering, Generating Stations, under local names.

MACHINE WORKS AND FOUNDRIES.

Bearings.

Steel Ball Bearings. Gives illustrated descriptions of these bearings with theoretical deductions by Dr. Heerwagen to ascertain the distribution of the load upon the different balls of a bearing. 3400 w. Engng—Dec. 26, 1902. No. 52690 A.

Boring Bar.

A Portable Boring Bar. Illustrated description of a machine designed for boring out stationary engine, locomotive, and pump cylinders without removing the cylinder from the frame or bed. 800 w. Am Mach—Jan. 1, 1903. No. 52783.

Cost Keeping.

See Industrial Economy.

Cupolas.

Long Heats in Small Cupolas. C. K. Weller. Considers some of the things that cause cupolas to bung up and shorten the time it can be kept in blast and gives suggestions for the proper management. 1400 w. Foundry—Jan., 1903. No. 52642.

Dies.

Cut and Carry Dies. G. Schneider. Describes and illustrates a die for making washers for bicycle rims, and its operation. 500 w. Am Mach—Jan. 1, 1903. No. 52786.

Feeding Sheet Metal to Dies. Joseph V. Woodworth. Illustrates and describes the various devices. 1500 w. Am Mach—Dec. 25, 1902. Serial. 1st part. No. 52782.

Drills.

Twist Drills. Corneil Ridderhof. Considers points relating to drills, their grinding, the stresses, etc. 2000 w. Am Mach—Jan. 1, 1903. No. 52784.

Drop Hammers.

Notes on the Evolution of the Drop Hammer for Die Forging. E. W. Merrill, Jr. An illustrated review of the development of this tool which is extensively used, especially describing the Brett drop-hammer. 1800 w. Eng News—Jan. 1, 1903. No. 52883.

Electric Driving.

See Electrical Engineering, Power Applications.

Engine Construction.

Fundamental Differences in the Construction of Gas and Steam Engines. P.

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Plantinga. Shows the difference in working conditions calls for entirely different designs and constructions. 1500 w. Eng News—Jan. 15, 1903. No. 53056.

Factory Management.

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Fan Blowers.

The Fan Blower and Its Application to the Cupola Furnace. R. B. Hayward. Read before the Pittsburg Foundrymen's Assn. An explanation of the forms of fan used for the movement of air, the laws under which the forces act, the problems encountered, etc., especially as applied to the cupola. 4200 w. Ir Age—Jan. 8, 1903. No. 52673.

Feeds.

Feeds and Speeds. Stanley H. Moore. Outlines the method used in the attempt to secure some definite knowledge on this subject. Diagrams. 1100 w. Am Mach—Dec. 25, 1902. No. 52781.

Forgings.

The Action of Iron and Steel Under Different Degrees of Heat. Gives an illustrated account of investigations which seem to establish that wrought iron is stronger when at a white heat than when at a red heat. 1800 w. Am Mach—Dec. 25, 1902. No. 52779.

Foundry Management.

Foundry Management in the New Century. Robert Buchanan. Mr. Buchanan's third paper discusses in detail the operations of moulding both by hand and by machine, with numerous illustrations. 4500 w. Engineering Magazine—February, 1903. No. 53289 B.

Gear Cutters.

Cut Gearing and Some American Machinery for Its Manufacture. Oscar J. Beale. A discussion of cut gearing and the causes of its noisiness, and illustrated descriptions of many gear-cutting machines. 3000 w. Cassier's Mag—Jan., 1903. No. 52803 B.

Grinding.

Two German Grinding Machines. Illustrates and describes a cylindrical grinding machine for internal grinding, and a link grinding machine which possess points of novelty. 700 w. Am Mach—Jan. 22, 1903. No. 53072.

Machine Tools.

Heavy Machine Tools at the Düsseldorf Exposition (Die Düsseldorfer Austellung —Die Riesen Werkzeugmaschinen). H. Unger. With illustrations of heavy milling, boring and planing machines; also lathes and special tools. Two articles. 6000 w. Glasers Analen—Jan. 1, 15, 1903. No. 53228 each D.

Machine Tool Progress. C. W. Obert. The present article gives illustrated descriptions of feed and drive mechanisms. 1500 w. Am Engr & R R Jour—Jan., 1903. Serial. 1st part. No. 52855 C.

Manholes.

The Weakening of Cylindrical Vessels by Cutting Manholes (Zwei Versuche zur Klarstellung der Verschwächung Zylindrischer Gefässe durch den Mannlochausschnitt). C. Bach. Data and results of experiments to test the reduction in strength due to non-reinforced manhole openings. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 3, 1903. No. 53203 D.

Molding.

The Advances in Molding Machinery. Harris Tabor. On the improvements and the future of molding machines. Ill. 1600 w. Ir Age—Jan. 1, 1903. No. 52670.

Piece Work.

Piece Work in Railway Shops. Gus Giroux. Read before the Canadian Ry Club. Shows the advantages of this system and gives suggestions for introducing it. 3500 w. Ry Age—Dec. 26, 1902. No. 52756.

Pneumatic Tools.

Applications of Compressed Air in Workshops (Emploi de l'Air Comprimé dans les Chantiers de Construction). A. Abraham. Describing compressing plant, reheaters and various forms of pneumatic tools, especially as used in the erection of structural work. Two articles. 4500 w. Génie Civil—Dec. 20, 27, 1902. No. 53-208 each D.

Railway Shops.

See Street and Electric Railways.

Risers.

Should a Riser be Open or Shut? James A. Murphy. Discusses when the riser should be left open and when closed, and gives suggestions of interest to molders. 1500 w. Foundry—Jan., 1903. No. 52643.

Rivetting.

Efficiencies of Riveted Lap Joints. C. G. Robbins. Gives tables covering both single and double-riveted lap joints of plates from ¼ to ½ inch in thickness, rivets from ½ to 1 inch in diameter, and pitches varying by sixteenths of an inch from 1¾ inches to 4⅛ inches, with explanation. 1500 w. Power—Jan., 1903. No. 52797 C.

Screw Machine.

2x12-inch Screw Machine. Illustrated description of a machine designed for handling long pieces and its equipment of tools being applicable to all classes of work requiring such operations as turning, threading, etc. 1300 w. Am Mach—Dec. 25, 1902. No. 52780.

Screw-Threads.

The Milling-Cutter Applied to the Pro-

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duction of Screw-Threads Illustrates and describes a new method of screw-cutting, and the special machine for carrying it out; the new feature being the use of a milling cutter for forming the thread. 2500 w. Ill. Eng News—Jan. 1, 1903. No. 52882.

Sheet Metal.

Horning and Seaming Processes. Joseph V. Woodworth. Illustrates and describes some of the devices and fixtures used. 1300 w. Am Mach—Jan. 1, 1903. No. 52785.

Shop Management.

Some Features of the Labor System and Management at the Baldwin Locomotive Works. John W. Converse. From an address before the Am. Acad. of Pol. & Soc. Sci., Phila. Describes methods adopted and features of interest. 4000 w. Ry & Engng Rev—Jan. 3, 1903. No. 52868.

Shop Records.

The "Duca" Card System. Robert Grimshaw. Gives card forms used by a German machinery manufacturer for keeping an account of office and shop items, with explanatory notes. 1900 w. Ir Trd Rev—Jan. 1, 1903. No. 52857.

Staybolted Surfaces.

Strength of Curved Staybolted Surfaces. C. G. Robbins. Explains the method of determining the safe working pressure of such surfaces. Ill. 3800 w. Power—Jan., 1903. No. 52850 C.

Tack-Making.

Plant of the Atlas Tack Company, Fairhaven, Mass. Illustrated detailed description of a carefully planned factory, equipped with automatic machinery, a modern power plant, and methods of power transmission. 2800 w. Eng Rec—Jan. 17, 1903. No. 53066.

Tramrail Systems.

Overhead Tramrail Systems in Shops and Foundries. A. W. Moyer. Read before the Philadelphia Foundrymen's Assn. An illustrated article showing the overhead tramrail to be an important labor saving factor, and describing briefly the kinds of rail most used and a few installations 4600 w. Ir Age—Jan. 22, 1903. No. 53068.

Tubes.

Some Recent Inventions Relating to the Manufacture of Iron and Steel Tubes. Edward C. R. Marks. The present article considers billet-piercing processes. Ill. 1700 w. Prac Engr—Dec. 26, 1902. Serial. 1st part. No. 52715 A.

Wire Nails.

Wire Nail Machines. Illustrated description of two recent machines which prevent waste and greatly increase the output. 2000 w. Ir & Coal Trds Rev—Jan. 16, 1903. No. 53090 A.

Work Shops.

The Designing and Construction of Modern Engineering Workshops. J. H. Humphreys. Read before the Manchester (England), Assn. of Engrs. An illustrated discussion of stanchions, crane girders, floors and floor girders, roof principals, and bracing 4500 w. Mech Engr—Dec. 13 and 20, 1902. Serial. 2 parts. No. 52737 each A.

MATERIALS OF CONSTRUCTION.

Alloys.

Industrial Alloys. Percy Longmuir. The present article considers modern steels as alloys, indicating the processes by which they are made. Also begins a discussion of copper alloys. 1500 w. Prac Engr—Jan. 2, 1903. Serial. 1st part. No. 52932 A.

Lubricants.

Oil vs. Grease as a Lubricant for the Plungers of Pumping Engines. William M. Davis. Gives an account of tests made with these lubricants which prove conclusively that the friction loss by use of grease is excessive. 900 w. Power—Jan., 1903. No. 52796 C.

Testing of Lubricants and Metals for Bearings (Méthode pour l'Experimentation des Huiles et Métaux pour Coussinets). Pierre Breuil. A discussion of the method of Dettmar, based upon the number of turns made by a free journal after disconnection. 2000 w. Génie Civil—Dec. 13, 1903. No. 53207 D.

Nickel Steel.

Investigations on Nickel Steel (Recherches sur les Aciers au Nickel). A. Pourcel. A note upon the investigations of Dumas regarding the bearing of the behavior of the high tension nickel steels upon the solution theory. 1000 w. Génie Civil—Dec. 27, 1902. No. 53211 D.

Testing.

A New Method of Testing Rails (Nouvelle Méthode d'Essai des Rails). Ch. Frémont. Describing the application of the nicked bar drop test to the investigation of steel rails. 1200 w. Comptes Rendus—Jan. 5, 1903. No. 53242 D.

Tool Steel.

High-Speed Tool Steel. An account of tests made to ascertain the increased efficiency obtained by the use of high-speed tool steel, and also the extra power required to drive the machines at the increased speed. 1500 w. Engng—Jan. 16, 1903. No. 53083 A.

Notes on High Speed Steel (Einige Betractungen über Schnelldrehstahle). Giving tabulated results of tests of the Bischoff steel, at cutting speeds of 16 to 64 metres per minute. 1500 w. Ill. Zeitschr

We supply copies of these articles. See page 973.

f Klein u Strassenbahnwesen—Dec. 16, 1902. No. 53285 D.

Wire Rope.

Rules for Working Loads of Wire Elevator Ropes. H. C. Newcomer. A statement giving information for determining the sizes of wire ropes and stresses for passenger elevators. 2200 w. Eng News—Jan. 15, 1903. No. 53052.

MEASUREMENT.

Dynamometer.

New Dynamometer for Road Traction Experiments. An illustrated description of a dynamometer fitted to an automobile, used by a British Association committee in traction experiments. 2000 w. Feilden's Mag—Jan., 1903. No. 53113 B.

See also Electrical Engineering Measurement.

Engine Tests.

A Remarkable Steam Engine Test. Report of a series of tests made by Prof. J. A. Ewing on an engine supplied with superheated steam. 1300 w. Engr, Lond—Jan. 9, 1903. No. 53033 A.

High Pressures.

The Estimation of High Pressures. Illustrated description of a new form of deadweight pressure gauge for the estimation of high pressures. 700 w. Engng—Jan. 9, 1903. No. 52995 A.

Planimeter.

The Planimeter, Explained Simply, Without Mathematics. W. J. Tennant. Abstracted from a paper read before the Inst. of Jr. Engrs. Explains the use of this instrument in making calculations. Ill. 2500 w. Engr, Lond—Jan. 16, 1903. No. 53089 A.

Recorders.

Autographic Load-Strain Recorder for Test Specimens. Prof. Goodman. Illustrates and describes an apparatus entirely automatic in its action. 1500 w. Engng—Dec. 19, 1902. No. 52684 A.

Weight.

The Weight of Solids of Revolution. George F. Summers. Brief illustrated description of an arrangement that performs computations automatically. 300 w. Am Mach—Jan. 15, 1903. No. 53049.

POWER AND TRANSMISSION.

Belting.

Power Transmission by Leather Belting (Transmissions par Courroies en Cuir). M. Gruffe. A mathematical analysis, with graphical diagrams enabling the capacity for various speeds and tensions to be seen. 1800 w. Revue Technique—Dec. 25, 1902. No. 53217 D.

Compressed Air.

Efficiency Tests of Compressed Air Machinery. W. C. Popplewell. Gives an illustrated detailed description of the methods employed and appliances necessary for tests of the different branches of a compressed air installation. 2300 w. Mech Engr—Jan. 10, 1903. Serial. 1st part. No. 52988 A.

Conveyors.

Computations for Screw Conveyors (Calculs Relatifs aux Transports par vis d'Archimède). J. E. Delliac. With practical examples, showing the transporting capacity of helical screw conveyors, for various dimensions and speeds. 1200 w. Revue Technique—Dec. 25, 1903. No. 53216 D.

Some American Conveying Machinery (Ueber Einige Amerikanische Umladevorrichtungen). R. Mellin. Illustrated description of modern American appliances for handling, conveying, and storing iron ore, coal, etc. 4500 w. 6 plates. Glückauf—Dec. 13, 1902. No. 53237 D.

Dynamometer.

See Electrical Engineering, Measurement.

Friction.

On Bearings for High Speeds. O. Lasche. A translation of a paper in the *Zeitschrift des Vereines Deutscher* Ingenieurs, giving the results of experiments on journal bearings made by the Allegemeine Elektricitäts-Gesellschaft, Berlin. 20,000 w: 8 plates. Trac & Trans—Jan., 1903. No. 53042 E.

Shafts.

Lining Up Shafts. H. J. Teiper. Gives suggestions for the lining up of shafting, favoring the lining up by the couplings. Suggestions apply not only to marine engines, but to stationary engines also. 2000 w. Power—Jan., 1903. No. 52798 C.

SPECIAL MOTORS.

Efficiency.

Cause of Increased Consumption in Gas and Gasoline Engines. Albert Stritmatter. Attributes the trouble to the lack of proper care. 1800 w. Am Mfr—Dec. 25, 1902. No. 52747.

Gas Engines.

Brake Horse-Power Combined Gas and Oil Engine (Butler's Patents). Illustrated description of an engine instantly interchangeable from town gas to kerosene oil, while running, without even having to switch off the electric lights for a moment. 500 w. Engng—Dec. 26, 1902. No. 52691 A.

Development of Gas Engines of Large Units. Fred B. Wheeler. Considers the

subject in regard to natural gas, producer gas, illuminating gas, and blast furnace gas; also pumping engines for natural gas and for water, central station use, and general power purposes. Ill. 2000 w. Ir Age—Jan. 1, 1903. No. 52667.

Important Gas Engine Installation. Gives an illustrated description of the Koerting gas engine of 1000 h. p., built for the Lackawanna Steel Co., Buffalo. There will be 8 engines of this size and 16 of 2000 h. p. each, all operated by blast furnace gas. 2800 w. Mach, N Y—Jan., 1903. No. 52858.

The Gas Engine—Availability of Power Gas. B. H. Thwaite. Reviews the work of the writer in this field, and also of other experimenters, showing the differences between the ideal power gases and other gases in use, the progress in gas engines, and the advantages of the new power gas system. Ill. 6000 w. Engr, U S A—Jan. 1, 1903. No. 52975.

The Use of Blast Furnace Gas in Gas Engines. Cecil Cochrane. Abstract of a paper read at meeting of Cleveland Inst. of Engrs. at Middlesbrough, Eng. Describes an engine in operation at the Ormesby ironworks, and the results of official trials of a gas-blowing engine, and methods employed. 1900 w. Col Guard—Dec. 19, 1902. No. 52680 A.

Varieties in the Design of Large Gas Engines (Verschiedene Constructionen von Grossgasmotoren). A communication from Herr Joh. Körting, discussing the construction and action of large gas engines, with especial reference to the mixture of the charge. 1800 w. 4 plates. Stahl u Eisen—Dec. 15, 1902. No. 53251 D.

Gas Power.

Furnace-Gas Motors at the Düsseldorf Exposition 1902 (Die Gichtgasmotore auf der Austellung Düsseldorf, 1902). W. Hübbe. With numerous illustrations of the various large engines exhibited for use with waste gases of blast furnaces. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53220 B.

Hydrocarbon Motors.

See Street and Electric Railways.

Petrol Motor.

See Mechanical Engng., Automobiles.

STEAM ENGINEERING.

Boiler Explosions.

A Remarkable Boiler Explosion. A discussion of the cause of the explosion at Swift & Co.'s, in Chicago, Nov. 29, 1902. 3000 w. Engr, Lond—Jan. 9, 1903. No. 53029 A.

Boiler Explosion in the Tow Boat Hermine (De Ontploffing van den Ketel in de Sleepboot Hermine). An account of a disastrous explosion of a cylindrical marine boiler, with photographs and detailed drawings. 2000 w. De Ingenieur—Dec. 13, 1902. No. 53247 D.

Boilers.

A New Departure in British Cruiser Machinery. The Question of Water-Tube Boilers. George Holliday. A well-illustrated description of various types of marine boilers and of the ships, both British and of other nations in which they are fitted. 5500 w. Cassier's Mag—Jan., 1903. No. 52801 B.

Concerning Naval Boilers. Substance of the report of the committee appointed by the British Admiralty to investigate the matter of boilers for use in the British navy. Ill. 3500 w. Locomotive—Nov., 1902. No. 52624.

Modern Boiler Practice. Charles H. Benjamin. Reviews the lines along which improvements have been made, the types at present in favor, improvement in setting of boilers, the use of mechanical stokers, and other appliances, with the results obtained. 2200 w. Engr, U S A—Jan. 1, 1903. No. 52974.

Modern Marine Boilers. H. M. Rounthwaite. Read before the Jr. Inst. of Engrs. Considers three types of boilers; the ordinary cylindrical, the "express" type of water-tube boiler, and the "ordinary" water-tube. 7500 w. Engr, Lond—Jan. 9, 1903. No. 53032 A.

Steam Boilers and Engines at the Düsseldorf Exposition (Les Chaudières et les Machines à Vapeur à l'Exposition de Düsseldorf). Ch. Compère. A comprehensive review of the steam machinery at Düsseldorf, showing the progress made since 1900. 12000 w. 2 plates. Mem Soc Ing Civ de France—Nov., 1902. No. 53280 G.

Sugden's Water-Tube Boiler. Illustrates and describes a new boiler possessing interesting features. 800 w. Engng—Jan. 2, 1903. No. 52935 A.

The Capacity of Cast Iron Sectional Steam Boilers. J. J. Blackmore. Paper presented at meeting of the Am. Soc. of Heat. & Ven. Engrs. Proposes a basis for establishing a standard rating for sectional cast-iron heaters in such terms as to enable the engineer to compare the performance of various makes. 1200 w. Eng Rec—Jan. 24, 1903. No. 53158.

The Seating of Lancashire Boilers. An illustrated article discussing points of importance in boiler setting. 1400 w. Prac Engr—Jan. 9, 1903. No. 52987 A.

Water-Tube Boilers. An illustrated discussion of the Belleville boiler, the Thornycroft water-tube boiler and the Yarrow boiler. 8000 w. Sci Am Sup—Dec. 27, 1902, and Jan. 3, 1903. Serial, 2 parts. No. 52770.

We supply copies of these articles. See page 973.

Condensing.

A "Towerless Cooling Tower" and Surface Condenser Combined. Illustrated description of a novel system of condensing for steam engines, particularly applicable where the supply of condensing water is limited, and where space available forbids the use of a cooling tower. 1200 w. Eng News—Dec. 25, 1902. No. 52875.

Connecting Rods.

Connecting and Coupling-Rods. P. H. Parr. Gives the results of an original analysis of the stresses in the connecting-rods and coupling rods of locomotives, indicating the methods of investigation used. 1200 w. Engr, Lond—Jan. 16, 1903. Serial. 1st part. No. 53085 A.

Engine.

Improved Poppet-Valve Engine (Neuerungen au Dampfmaschinen mit Ventilsteuerungen). Fr. Freytag. Illustrated description of the Lentz steam engine, using a combined eccentric and cam valve gear with poppet valves. 3500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Dec. 20, 1902. No. 53200 D.

The Machinery of the Orient-Pacific Liner "Orontes." Illustration, with description, of one of the twin sets of quadruple-expansion engines, and a general description of the vessel. 1200 w. Engng—Jan. 2, 1903. No. 52938 A.

The Reciprocating Steam Engine—Its Status, Its Rivals, and Its Apparent Future. R. H. Thurston. Reviews the development of the steam engine and the wide field is has occupied, commenting briefly on the rivalry of gas engines and steam turbine. 2800 w. Engr, U S A—Jan. 1, 1903. No. 52973.

The Williams Engine. Illustrated description of a new type of vertical compound engine. 1500 w. Power—Jan., 1903. No. 52795 C.

2000-Horse-Power Twin Tandem Steam Engine. An illustrated description of an engine exhibited at Düsseldorf which was built by the Grevenbroich Company. 700 w. Engng—Jan. 9, 1903. No. 52997 A.

Engine Construction.

See Mechanical Engineering, Machine Works and Foundries.

Engine Tests.

See Mechanical Engng., Measurement.

Entropy.

Entropy. J. Swinburne. An elaboration of the views expressed in the author's recent presidential address before the Inst. of Elec. Engrs., attacking the ordinary definitions of entropy based on completely reversible thermo-dynamic processes. 3500 w. Elec Rev, Lond—Jan. 9, 1903. No. 53125 A.

Firing.

Comparative Economy of Stoking and Hand Firing. Julius Geldard. Particulars of tests with account of the measuring methods employed. Ill. 2700 w. Mech Engr—Jan. 3, 1903. No. 52931 A.

Governors.

Marine Engine Governors. Jasper E. Cooper. Illustrated descriptions of different governors for marine steam engines. 3500 w. Feilden's Mag—Jan., 1903. No. 53112 B.

Heat Transmission.

The Relation of Heat Emission to Steam Pressure (Zur Generellen Regelung der Wärmeabgabe der Heizkörper bei Niederdruck durch die Höhe der Dampfspannung). O. Hunaeus. A discussion of the author's formulas in view of their use by Prof. Rietschel; with response by the latter. 3000 w. Gesundheits-Ingenieur—Dec. 31, 1902. No. 53243 B.

Liquid Fuel.

Liquid Fuel for Electrical Stations. W. H. Booth. A general discussion of the question of oil fuel. 2500 w. Elec Rev, Lond—Jan. 2, 1903. No. 52816 A.

Rotary Engine.

The Hult Rotary Steam Engine. Illustrated description of an engine in which the cylinder participates in the rotary motion of the piston, and which is now being made in sizes up to 250 horse power. 1800 w. Feilden's Mag—Jan., 1903. No. 53116 B.

Steam Plants.

The Development of Steam Power Plants. George H. Barrus. Discusses the important changes during the last twenty-five years. 2500 w. Eng Rec—Jan. 3, 1903. No. 52916.

The Modern Plant. W. H. Wakeman. Practical directions and suggestions concerning its design and operation, and means of determining the size of a plant to develop a given power. 2000 w. Mod Mach—Jan., 1903. No. 52604.

Steam Turbine.

Progress in the Introduction of the Steam Turbine. J. R. Bibbins. A review of the development of the various forms of steam turbine in actual use, with especial reference to work in the United States. 4000 w. Engineering Magazine—February, 1903. No. 53293 B.

The Steam Turbine and the Future of Heat Engines (Die Dampfturbinen und die Aussichten der Wärmekraftmaschinen). A. Stodola. A discussion of the thermodynamic and mechanical features of the steam turbine, showing its influence upon the development of heat motors. Serial, Part I. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 3, 1903. No. 53201 D.

We supply copies of these articles. See page 973.

Superheated Steam.

Effect of Superheated Steam Upon the Tensile Strength of Alloys. J. L. Hall. An account of experimental investigations, descriping methods employed and giving results obtained with two alloys of copper. Ill. 1400 w. Metallographist—Jan., 1903. No. 53129 F.

U. S. Mint.

Coining at the New Mint at Philadelphia. Joseph V. Woodworth. A brief description of the different processes. 3200 w. Am Mach—Jan. 8, 1903. No. 52788.

The Mechanical Heating Processes in the New United States Mint at Philadelphia. States the advantages derived from the use of gas as a fuel in the principal departments, and gives illustrated descriptions of the plant, machines, processes, etc. 3000 w. Am Mach—Jan. 22, 1903. No. 53071.

Valve Gears.

Double Slide Valve Gears for Steam Engines (Doppelschiebersteuerungen fur Dampfmaschinen). B. Stein. A discussion of various forms of cut-off gear operating by one valve sliding on or in another, with especial reference to the piston-valve engine of Haniel & Lueg. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 3, 1903. No. 53202 D.

Setting the Valves of the McIntosh & Seymour Engine. Illustrated detailed description. 1800 w. Power—Jan., 1903. No. 52799 C.

Valves.

Large Stop Valves for High-Pressure Steam. J. Hamilton Gibson. Read before the N. of England Inst. of Engrs. and Shipbuilders. Abstract. Gives a brief illustrated description of a new valve, or rather an altered valve, and its successful working. 1200 w. Col Guard—Dec. 24, 1902. No. 52682 A.

MISCELLANY.

Aeronautics.

Aerial Navigation (Navigation Aérienne). Rodolphe Soreau. A critical study of the scientific principles involved in the resistance of the air, in balancing, supporting and the essentials of aerial navigation. An important paper. 20,000 w. Mem Soc Ing Civ de France—Oct., 1902. No. 53279 G.

Heating and Ventilating.

Heating and Ventilating by Forced Blast. Chas. L. Hubbard. A discussion of fans and blowers and their application to heating and ventilating systems. 3000 w. Am Elect'n—Jan., 1903. No. 53014.

Heating and Ventilating During the Past Twenty-five Years. W. J. Baldwin. Reviews the early history, naming those who aided the advancement, and the methods used. Principally considering steam. 3000 w. Eng Rec—Jan. 3, 1903. No. 52917.

Mechanical Plant.

Mechanical Equipment of the Macy Building, New York City. D. M. Quay. An illustrated description of the heating, ventilating and power plant of a modern mercantile building. 3000 w. Steam Engng—Jan. 10, 1903. No. 53043.

The New Mechanical Plant of the Mutual Life Building, New York. Illustrates and describes an extensive plant containing many features of interest. 4300 w. Eng Rec—Jan. 17, 1903. No. 53067.

MINING AND METALLURGY

COAL AND COKE.

Belgium.

The Coal Districts of Northern Belgium (Das Nordbelgische Kohlenworkommen). H. Mentzel. A review of the geology of Northern Belgium, with a sketch map showing the location of coal depotits. 1800 w. 1 plate. Glückauf—Dec. 27, 1902. No. 53238 D.

Coal-Dust Explosions.

The Origin of Coal-Dust Explosions. James Tinsley. Read before the Monmouthshire Colliery Officials Assn. Discusses the causes of these explosions, and urges that in mines yielding inflammable dust shot-firing be prohibited. 4300 w. Ir & Coal Trds Rev—Dec. 19, 1902. No. 52702 A.

Coal Trade.

See Industrial Economy.

Coal Washing.

The Coal Washing Plant at the Wilczek Mine in Pollnisch-Ostrau (Die Kohlenwäscherei am Dreifaltigkeitsschachte in Polnisch-Ostrau). Hugo Hofer. Detailed description of a modern coal washing plant in Northern Austria. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 20, 1902. No. 53233 D.

Coke.

The Coke Industry. Fred C. Keighley. An explanation of the present situation due to inadequate transportation facilities, discussing some features of the trouble. 2500 w. Ir Age—Jan. 1, 1903. No. 52665.

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Colorado.

The Trinidad or El Moro Coal Region of Colorado. Abstract of a monograph by Prof. R. G. Hills of U. S. Geol. Survey. Gives illustrated description of the geology of the region, its mines, etc. 2500 w. Mines & Min—Jan., 1903. No. 52960 C.

Explosives.

Explosives in Coal Mines. A New Order. Gives the order issued Dec. 20, 1902, revoking all other orders. 3000 w. Ir & Coal Trds Rev—Jan. 9, 1903. No. 53035 A.

Production.

Coal in 1902. Samuel Sanford, and other writers. Articles reviewing the whole production, and by districts, and matters that have affected the industry. 15000 w. Eng & Min Jour—Jan. 3, 1903. No. 52906.

Screening.

The Allard Coal-Screening Method. F. Esser, in *Glückauf*. Brief illustrated description. 500 w. Col Guard—Dec. 24, 1902. No. 52681 A.

Waste.

Prevention of Loss and Waste in Coal-Working. John Brown. 2nd Prize Essay. Considers the causes of waste and offers suggestions for economy. 4000 w. Ir & Coal Trds Rev—Dec. 19, 1902. No. 52701 A.

COPPER.

Assaying.

The Copper Assay by the Iodide Method. Albert H. Low. From the *Jour. Am. Chem. Soc.* A description of the assay as now carried out, improvement in details leaving little to be desired on the score of accuracy. 1800 w. Eng & Min Jour—Dec. 27, 1902. No. 52889.

Copper Industry.

Copper as a Factor in Industrial Progress. James Douglas. Showing the importance of this branch of industrial wealth and giving information of interest. 1700 w. Ir Age—Jan. 1, 1903. No. 52669.

Production.

Copper in 1902. Articles by Frederick Hobart, James Douglas and other writers, reviewing the year's production, the markets, mining, etc. 5000 w. Eng & Min Jour—Jan. 3, 1903. No. 52895.

Spain.

The Rio Tinto Mines. Alfred Harvey. An illustrated description of these copper mines in Spain which have been worked hundreds of years. 1300 w. Min Rept—Jan. 22, 1903. No. 53134.

GOLD AND SILVER.

Assaying.

Sources of Error in the Fire Assay of Gold and Silver Ores. P. G. Morgan. Calls attention to the various sources of error, avoidable and unavoidable, discussing their probable amount and the remedies. 5800 w. N Z Mines Rec—Nov. 17, 1902. No. 52609 B.

California.

Recent Developments on the Mother Lode. Ernest R. Woakes. Shows what is being done in Amador County and vicinity to make the low-grade gold ore pay when occurring at depths of 2000 ft. and over. 2000 w. Eng & Min Jour—Jan. 24, 1903. No. 53160.

Cyanide Process.

A Review of the Cyanide Process in the United States During 1902. Charles H. Fulton. Reviews the progress in each state, showing more extended application and improvement of details. 7800 w. Eng & Min Jour—Jan. 3, 1903. No. 52900.

Collecting Pyritic Material for Cyanide Treatment. Edgar Smart. An illustrated article supplementary to previous papers on "Developments in Cyanide Practice." 1000 w. Page's Mag—Jan., 1903. No. 53-111 B.

Use of Lime as an Alkaline Reagent in Cyaniding. Ernest Gayford. An account of tests made at the Mercur Mill, Manning, Utah, to ascertain the cause of the abnormal consumption of cyanide, giving results. 1200 w. Min & Sci Pr—Jan. 3, 1903. No. 52952.

Drainage.

The Cripple Creek, Colo., Drainage Tunnel. W. B. Wilson. Describes this district, the water occurrence, and discusses the steps necessary to solve the water question, and the vast issues at stake. 3000 w. Min & Sci Pr—Jan. 17, 1903. No. 53136.

Drift Mining.

An Experience in Drift Mining in Hard Cement Gravel. L. H. Carver. Describes the methods employed in the operation of a drift mine in Calaveras Co., Cal. Mans. 1500 w. Min Sci Pr—Jan. 3, 1903. Serial. 1st part. No. 52953.

Electric Refining.

See Electrical Engineering, Electrochemistry.

Gold Dredging.

The Development of Gold-Dredging in the United States. Ralph L. Montagu, in *Mining Journal*, London. A comparison with New Zealand methods and costs. 2800 w. N Z Mines Rec—Dec. 16, 1902. No. 53094 B.

Gold Fields.

Yorkey's Goldfield, and the Marodian Gold and Copper Field. Lionel C. Ball. Gives the history, geology, topography, etc., and describes various mines in and near these fields. 7300 w. Queensland

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Gov Min Jour—Nov. 15, 1902. No. 52-734 B.

Kalgoorlie.

Metallurgical Methods at Kalgoorlie, W. A. E. Barton Hack. Reviews some of the different methods of extracting gold from the refractory ores. 2200 w. Eng & Min Jour—Jan. 24, 1903. No. 53161.

Localization.

An Example of the Localization of Rich Ore. T. A. Rickard. Facts collected in regard to the Independence mine, in the Cripple Creek District, principally. Ill. 1800 w. Eng & Min Jour—Dec. 27, 1902. No. 52890.

Nevad...

The Geologic and Economic Aspect of Tonopah, Nevada. Describes the unusual conditions of this mining district, which gives promise of proving a large producer of bullion. 1800 w. Min & Sci Pr—Jan. 10, 1903. No. 53063.

New Mexico.

New Mexico Mines in 1902. Charles R. Keyes. Review of a very prosperous year, and of the work of the different mines yielding gold, silver, copper, lead, zinc and other minerals. 1800 w. Eng & Min Jour—Jan. 17, 1903. No. 53064.

Ontario.

The Eastern Ontario Gold Belt. Prof. Willet G. Miller. Abstract of a paper in the Report of the Ontario Bureau of Mines. Describes the geology of the district and the gold deposits. 1000 w. Eng & Min Jour—Dec. 27, 1902. No. 52891.

Placers.

Summit County Placers of Colorado. Prof. Arthur Lakes. An illustrated description of the great hydraulic works now nearing completion near Breckenridge. 2500 w. Mines & Min—Jan., 1903. No. 52956 C.

Production.

The Production of Gold and Silver in the World During 1902. Reviews by Joseph Struthers, J. O. Heimberger, J. W. Neill, and others in regard to the production of various districts. 10500 w. Eng & Min Jour—Jan. 3, 1903. No. 52896.

Sampling.

Notes on Mine Sampling of the Main Reef Series. D. J. Williams. Considers the methods in use and the equipment needed, sectional drawings and points of importance. Ill. 5500 w. Jour Chem & Met Soc of S Africa—Oct., 1902. No. 52984 E.

Sluicing.

Sluicing for Gold in Queensland. Describes the system of working on the Russell goldfield. Ill. 2800 w. Queensland Gov Min Jour—Nov. 15, 1902. No. 52733 B.

Smelting.

The Economic Use of Petroleum Oil Gas Furnaces as Applied to Smelting, Laboratory Work, and Drill Heating. David Laird. On the adaptability of these furnaces for metallurgical work, treating them purely from a mechanical point of view and showing their advantages in certain kinds of work. 5300 w. Jour Chem Met Soc of S Africa—Oct. 1, 1903. No. 52985 E.

The Lead Smelting of Zinc Gold Slimes. P. S. Tavener. A full description of the writer's method of smelting zinc gold slimes with litharge, which appears to present advantages in economy and speed. Also describes the furnaces used. Ill. 11-000 w. Jour Chem & Met Soc of S Africa —Oct., 1902. Discussion in Nov., 1902. No. 52983 each E.

The Use of Crude Oil in Smelting. Alfred von der Ropp. Abstract of a paper read before the California Miners' Assn. Setting forth the economy and advantages derived from the use of this fuel. 1600 w. Eng & Min Jour—Jan. 10, 1903. No. 52968.

South Africa.

Gold Mining in South Africa in 1902. W. Fischer Wilkinson. A short review of events previous to this year and their effects, with report for the last year. 2400 w. Eng & Min Jour—Jan. 3, 1903. No. 52897.

Stamp Milling.

Stamp Milling and Amalgamation of Free Gold Ores. Dana Harmon. The first of a series of articles giving the writer's methods and conclusions on the treatment of ores. 2500 w. Min & Sci Pr—Jan. 17, 1903. Serial, 1st part. No. 53137.

IRON AND STEEL.

Bertrand-Thiel.

Notes on the Bertrand-Thiel Process (Betrachtungen über das Bertrand-Thiel Verfahren). A. Ledebur. With tables and diagrams showing the action at successive stages of the process. 2500 w. Stahl u Eisen—Jan. 1, 1903. No. 53254 D.

Blowholes.

The Influence of Chemical Composition Upon the Formation of Blowholes in Low Steel Ingots (Der Einfluss der Chemischen Zusammensetzung auf die Blasenbildung in Flusseisenblöcken). Axel Wahlberg. A review of the investigations of Brinell, collecting his results into diagrams. 2500 w. Stahl u Eisen—Jan. 1, 1903. No. 53256 D.

Briquetting.

Briquetting:—Its History, Value and

Possibilities in the Iron Industry. Henry S. Mould. Reviews the history of briquetting iron ores and the writer's experience in the work, some of the difficulties encountered and the present success, with advantages claimed. Discussion. Ill. 6600 w. Pro Engrs Soc of W Penna—Nov., 1902. No. 53036 D.

Cast Iron.

Some Unusual Crystals of Cast Iron. J. E. Johnson, Jr. Illustrates some interesting crystals, giving their analysis and an account of their origin. 1700 w. Metallographist—Jan., 1903. No. 53131 F.

Desulphurizing.

Manganese Ore as a Desulphurizing Material in the Basic Open-Hearth Process (Manganerz als Entschwefelungsmittel beim Basischen Martinverfahren). A. Riemer. Data and results of experience at the Pastuchoff Iron Works, Sulina, Russia, showing the extent to which the use of manganese ore carried the sulphur into the slag. 2000 w. Stahl u Eisen—Dec. 15, 1902. No. 53252 D.

Electric Power.

See Electrical Engineering, Power Applications.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Hematite.

The Parapara Hematite Deposits. Extracts from Geological Survey reports, giving information in regard to these deposits and their probable origin and value. 3800 w. N Z Mines Rec—Dec. 16, 1902. No. 53093 B.

Iron Trade.

See Industrial Economy.

Ontario.

Types of Iron-Bearing Rocks in Ontario. A. P. Coleman. Brief descriptions of the types of iron ore deposits found in the province. 900 w. Eng & Min Jour—Dec. 27, 1902. No. 52888.

Open-Hearth.

Open-Hearth Steel Plant of the American Steel Casting Co., at Alliance, Ohio. From a description prepared by L. L. Knox. Gives general features, construction of furnaces, etc. Ill. 2500 w. Foundry—Jan., 1903. No. 52641.

Ore Handling.

Modern Handling of Iron Ore on the Great Lakes. Jas. N. Hatch. Describes modern methods of mining and transportation during the last fifty years in the territory between the Lake Superior iron mines and the Pittsburg iron district. Ill. 12000 w. Jour W Soc of Engrs—Dec., 1902. No. 52659 D.

Production.

Iron and Steel in 1902. Articles by Frederick Hobart and others, reviewing the enormous production of the year and matters of related interest. 9500 w. Eng & Min Jour—Jan. 3, 1903. No. 52905.

Prussia.

The Iron Industry of the Siegerland. An illustrated historical account of this district in regard to the iron industry. There are 21 works, with 33 blast furnaces, with an annual output of about 700,000 tons of pig iron. 2200 w. Ir & Coal Trds Rev—Dec. 12, 1902. No. 52700 A.

Rolling Mill.

The Rolling Mills of the Differdingen Iron Works (Die Walzwerkanlage der Deutsch-Luxembergischen Bergwerks, Differdingen). With numerous views of the various departments of the works. 1800 w. Stahl u Eisen—Jan. 1, 1903. No. 53257 D.

Russia.

The South Russian Iron Industry. Archibald P. Head. Gives results of recent investigations of these industries, having had exceptional facilities for examining them from a metallurgical as well as a commercial standpoint. Maps, illustrations and discussion. 8000 w. Jour Soc of Arts—Dec. 19, 1902. No. 52619 A.

Steel Analysis.

Should Analysis Be Included in Steel Specifications? Extracts from an article by Herr Knaudt in *Stahl und Eisen*, with remarks. 1400 w. Ir Age—Jan. 8, 1903. No. 52674.

Steel Castings.

Annealed Steel Castings (Temperstahlguss). Bernard Osann. A description of the plant and methods of the Gelsenkirchen works, the largest establishment in Germany for the production of steel castings. 5000 w. Stahl u Eisen—Jan. 1, 1903 No. 53253 D.

Steel Works.

The Duquesne Works of the Carnegie Steel Company. The present article gives an illustrated description of the open-hearth plant and the blooming and 14-inch Morgan continuous mills. 3500 w. Ir Age—Jan. 1, 1903. Serial, 1st part. No. 52666.

Steel.

On the Simultaneous Presence of Ferrite and Cementite in Steel. E. F. Lange. A critical note, showing that the statement that "structurally free ferrite and structurally free cementite never exist together in the same steel." is incorrect. 1500 w. Metallographist—Jan., 1903. No. 53130 F.

Unexplained Phenomena in Steel.

We supply copies of these articles. See page 973.

Translated from the *Journal de l'Electrolyse*. States some of the peculiarities whose causes are yet unknown, and the need of employing the pyrometer and the microscope in its manufacture. 1400 w. Am Mfr—Jan. 22, 1903. No. 53127.

Sulphur.

Sulphide of Iron: Its Properties and Its Conditions in Iron. H. Le Chatelier and M. Ziegler in *Bull Soc d'Encour.* A study of the relations of sulphur with iron and manganese. Ill. 4000 w. Metallographist—Jan., 1903. No. 53132 F.

MINING.

Argentine.

The Mines of Argentina. R. B. Brinsmade. An account of the adaptation, by the natives, of the methods of working to the requirements and limitations of the country. 5000 w. Mines & Min—Jan., 1903. No. 52962 C.

Australasia.

The Mining Industry of Australasia in 1902. F. Danvers Power. Reports a year of depression on account of low price of metals and prevailing drought. Reviews the year. 3800 w. Eng & Min Jour—Jan. 3, 1903. No. 52899.

British Columbia.

The British Columbian Mining Industry of 1902. Review of the operations of the past year giving an approximate estimate of the production of gold, silver, lead, copper, coal and other minerals. Ill. 4300 w. B C Min Rec—Jan., 1903. No. 52966 B.

Deep Mines.

Earth Pressures in Deep Mines. Considers that it is probable that at great depths pressures will be encountered that the timbering necessary to resist them will become an item of great expense. 2200 w. Col Guard—Jan. 2, 1903. No. 52947 A.

Education.

The Training of a Mining Engineer. R. A. S. Redmayne. Read before the So. Staffordshire and E. Worcestershire Inst. of Min. Engrs. A comparison of the present status of colliery managers with the position and requirements of those in the early history of the coal trade, showing the ever growing necessity for further scientific education. 4000 w. Col Guard—Dec. 19, 1902. No. 52679 A.

Electric Power.

See Electrical Engineering, Power Applications.

Explosives.

The Testing of Explosives in Belgium. An account of a new testing station for explosives recently fitted up by the Belgian Administration des Mines, for the investigation of the behavior of explosives under all conditions likely to occur in practice. 1800 w. Col Guard—Jan. 9, 1903. No. 52994 A.

The Theory of Missfires and Some Conclusions of Practical Value. E. H. Weiskopf. Considers missfires occurring with nitroglycerine explosives. 3200 w. Jour Chem & Met Soc of S Africa—Nov., 1902. No. 52979 E.

Fans.

Centrifugal Fans. Charles H. Innes. A study of laws, of service in the designing and affecting the efficiency of fans; the measuring of the work done by a fan, etc. Ill. 2500 w. Prac Engr—Jan. 16, 1903. Serial. 1st part. No. 53092 A.

Haulage.

Underground Wire Rope Haulage. Gives illustrated descriptions of features of the tail rope system as operated in the workings of a mine in Illinois. 1700 w. Sci Am Sup—Dec. 27, 1902. No. 52769.

Hydraulic Mining.

Proposed Retaining Barriers for the Débris from Hydraulic Mining in the Yuba River, Cal. Brief description of the methods adopted by the California Débris Commission. Ill. 1400 w. Eng News—Jan. 15, 1903. No. 53053.

Idaho.

The Bellevue Mining District of Idaho. Prof. Arthur Lakes. Illustrates and describes the geological peculiarities of the veins as shown in the Minnie Moore and the Queen of the Hills mines. 1800 w. Mines & Min—Jan., 1903. No. 52961 C.

Mine Pumping.

The "Dense Air" System of Power Transmission in Deep Mine Pumping. D. A. McNeill. Illustrated description of a plant recently installed at the Bisbee West Copper Min. Co.'s Shaft No. 1, which uses air as a means of power transmission. 800 w. Eng & Min Jour—Dec. 27, 1902. No. 52893.

Mining Management.

The General Management of Metalliferous Mines. Albert Williams, Jr. Mr. Williams's second paper discusses the important question of the relations between the technical and business departments showing the conditions tending to greatest commercial efficiecy. 3500 w. Engineering Magazine—February, 1903. No. 53291 B.

Ore Deposits.

Redcliffe Ore Deposits. Prof. Arthur Lakes. Describes the characteristics of these deposits which are not unlike in some respects to the ore deposits of the Mancos Contact and the American Nettie at Ouray. 1000 w. Mines & Min—Jan., 1903. No. 52959 C.

Ore Dressing.

Static Electricity Applied to Ore Dress-

ing. W. G. Swart. Illustrates and describes a method of ore separation which consists in bringing the ore particles into contact with a statically charged metallic surface, the separation being effected by the difference of conductivity. The invention of Lucien I. Blake and Lawrence N. Morscher. 1300 w. Eng & Min Jour—Jan. 24, 1903. No. 53159.

The Highland Ore Dressing Mill, British Colombia. Ernest R. Woakes. Abstract of a paper read before the Inst. of Min. & Met., London. An illustrated description of the plant. 1200 w. Eng & Min Jour—Dec. 27, 1902. No. 52892.

Power Distribution.

Various Methods of Conveying Power to the Interior of Mines. T. Lindsay Galloway. Read before the Glasgow Univ. Engng. Soc. Describes briefly some of the systems which have been applied in mines, indicating why different methods have found suitable spheres of application. 3200 w. Col Guard—Jan. 9, 1903. Serial. 1st part. No. 52992 A.

Production.

The Production of Minerals and Metals in the United States During 1902. Joseph Struthers. General review with table of statistics. 4400 w. Eng & Min Jour—Jan. 3, 1903. No. 52894.

Rock Drills.

The Rock Drill Question in 1902 (Die Gesteinbohrmaschinen frage im Jahre 1902). H. Drolz. A comparison of the relative merits of compressed air and electricity for operating rock drills, with data from recent experience. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 20, 1903. No. 53234 D.

Shaft Sinking.

Sinking a Shaft by Compressed Air. Bergassessor Lüthgen, in *Glückauf*. States the conditions and describes the work and the difficulties encountered. Ill. 1800 w. Col Guard—Jan. 9, 1903. No. 52993 A.

Sinking by the Freezing Method at Washington, County Durham. Mark Ford. Abstract of a paper read before the N. of England Inst. of Min. & Mech. Engrs. Detailed description of sinking through alluvial deposits to the stone-head. 2500 w. Ir & Coal Trds Rev—Dec. 19, 1902. No. 52703 A.

Timbering.

Lining Galleries Exposed to Heavy Rock Pressure. Bergassessor Jacob, in *Glückauf*. Illustrates and describes the method adopted in the Neumehl pit. The galleries were lined with closed U-iron rings. 600 w. Col Guard—Dec. 12, 1902. No. 52677 A.

Mine Timbering in the Old Ironsides and Knob Hill Mines. H. P. De Pencier. Briefly describes these mines in British Columbia, which require an extensive system of timbering. 3700 w. Min & Sci Pr—Dec. 20 & 27. Serial. 2 parts. No. 52775.

The Working of Seams and Faults in Coal Measures (Studien über das Auftreten von Schnitten und Schlechten in der Kohle). H. Fleck. A description of the methods of timbering employed in the Shamrock mine at Wanne in the Ruhr district. 2000 w. 4 plates. Glückauf—Jan. 3, 1903. No. 53239 D.

Winding.

Winding Ropes in Belgium. Abstract of the results of an inquiry into the conditions of service of winding ropes in Belgian Collieries, both in regard to Manilla hemp and steel ropes. 2500 w. Col Guard—Jan. 16, 1903. No. 53079 A.

MISCELLANY.

Nickel.

The Canadian Nickel Industry. An editorial discussing the general situation of the nickel industry, especially in Canada. 2000 w. Engng—Jan. 9, 1903. No. 53026 A.

The Sudbury Nickel Mines. A. McCharles. Reviews events affecting the nickel mining industry. 1700 w. Eng & Min Jour—Jan. 3, 1903. No. 52901.

Quicksilver.

The Terlingua Quicksilver Deposits of Texas. B. F. Hill. Describes these deposits, methods of mining, etc. Ill. 1600 w. Min & Sci Pr—Jan. 17, 1903. Serial. 1st part. No. 53138.

Tin.

Notes on Tin Mining in Bolivia. J. B. Minchin. Information concerning the deposits and their mining, concentration, etc. 1400 w. Eng & Min Jour—Jan. 3, 1903. No. 52903.

Tin Deposits of the York Region, Alaska. Edgar Rickard. Discusses the geology and economic conditions. 1000 w. Eng & Min Jour—Jan. 3, 1903. No. 52902.

The Briseis Tin Lead at Derby, Tasmania. Edgar Rickard. Describes this district, the deposits, the difficulties met in the recovery of the tin, methods adopted, etc. Map. 1800 w. Eng & Min Jour—Jan. 17, 1903. No. 53065.

Zinc.

Zinc in 1902. Articles by Joseph Struthers, Walter Ranton Ingalls and Frank Nicholson reviewing the progress of the zinc industry. 5200 w. Eng & Min Jour—Jan. 3, 1903. No. 52904.

We supply copies of these articles. See page 973.

RAILWAY ENGINEERING

MOTIVE POWER AND EQUIPMENT.

Braking.

The Hibbard Valve for Braking Empty and Loaded Cars. An illustrated description of a device which has been in service for some time on the Burlington & Missouri Rivers. 2000 w. R R Gaz—Jan. 23, 1903. No. 53172.

Car Mountings.

Manufacture of Car Mountings at the Shops of the Eastern Railway of France at Mohon (Fabrication des Ferrures aux Ateliers de la Cie d'Est à Mohon). L. Tolmer. A very complete account of the works and tools for the production of the metallic parts of railway cars, showing the processes in detail. 10,000 w. Revue de Mécanique—Dec. 31, 1902. No. 53272 E +F.

Coaling.

Modern Methods of Coaling Locomotives. An illustrated description of the Mt. Pleasant coaling station, of the St. Louis Southwestern Ry. system. 1100 w. Ry & Engng—Dec. 27, 1902. No. 52867.

Couplers.

Automatic Couplers for Railway Cars Selbstthatige Kuppelungen für Eisenbahnfahrzeuge). Ernst Sauer. A discussion of the adaptability of the standard couplers of the American Master Car Builders' Association, in connection with the existing screw couplers of Germany. 7000 w. Glasers Annalen—Dec. 15, 1902. No. 53226 D.

Draft Gear.

The Essentials of a Good Draft Gear. E. M. Herr. Defines the term "draft gear" and discusses as essentials, the draw bar, adjustable yielding resistance, and fixed attachments. 1200 w. Pro of Ry Club of Pittsburg—Dec. 26, 1902. No. 53069.

The Essentials of a Good Draft Gear. Roy V. Wright. Considers some of the essentials to be a capacity of at least 100,000 pounds; a draw-bar movement of at least two inches; small amount of recoil; simple and substantial design. 700 w. Pro of Ry Club of Pittsburg—Dec. 26, 1902. No. 53070.

Locomotive Boilers.

Evolution of the Locomotive Boiler. O. H. Reynolds. A review of the progress during the last 100 years. Ill. 2000 w. Loc Engng—Jan., 1903. No. 52743 C.

The Dimpfel Boiler. C. H. Caruthers. Brief illustrated description of a type built in 1856. 900 w. Loc Engng—Jan., 1903. No. 52744 C.

The Explosion of Modern Locomotive Boilers. Considers faulty design as a contributing cause in connection with low water. 1500 w. Ry Age—Jan. 2, 1903. No. 52757.

Locomotive Construction.

The Building of an American Locomotive. Frank H. Fayant. An illustrated account of standard locomotive construction in the United States, based upon practice in the Baldwin works at Philadelphia. 5000 w. Page's Mag—Jan., 1903. No. 53110 B.

Locomotives.

A Curious Locomotive. Brief illustrated description of a design of Mr. Michael Reynolds, patented in 1895. 450 w. Engr, Lond—Jan. 16, 1903. No. 53088 A.

Consolidation Locomotive of the Chicago Terminal Transfer Railroad. Illustrates and describes locomotives designed to meet the unusual requirements of the switching service about the Chicago terminals. 400 w. Ry Age—Dec. 26, 1902. No. 52755

Four-Cylinder Balanced Compound Locomotives. Designs and extracts from two letters received by W. F. M. Goss, giving suggestions for new designs of balanced engines and the advantages claimed. Ill. 700 w. R R Gaz—Jan. 2, 1903. No. 52924.

Göldsdorf Compound Locomotives. Reginald Gordon. An illustrated article stating some of the advantages claimed by this system. 1400 w. R R Gaz—Jan. 16, 1903. No. 53058.

Heavy Compound Freight Locomotives. Illustrated description of the heavy Vauclain compounds, the 2-8-2 (Mikado) type, building for the Atchison, Topeka & Santa Fe Ry. 300 w. Am Eng & R R Jour—Jan. 1903. No. 52854 C.

Narrow-Gauge Locomotive for Indian States Military Light Railways. Illustration with brief description. 400 w. Engng—Dec. 26, 1903. No. 52692 A.

New Canadian Pacific Passenger Locomotives. Drawings and description. 600 w. Ry Age—Dec. 19, 1902. No. 52751.

Side Tank Switching Locomotive for the Kanawha and Michigan. Illustrated description of an engine of the "Calumet" type designed to work on 4 and 4½ per cent. grades. 1500 w. Ry Age—Jan. 2, 1903. No. 52758.

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Ten-Wheel Passenger Locomotive. Canadian Pacific. Illustrated description of new engines with features of interest. 500 w. R R Gaz—Jan. 2, 1903. No. 52925.

The Growth of the Locomotive. Angus Sinclair. The first of a series of illustrated articles reviewing the development, the first locomotives to run upon rails having been built 100 years ago. 3500 w. Loc Engng—Jan., 1903. Serial. 1st part. No. 52740 C.

Rolling Stock.

Railway Rolling Stock at the Düsseldorf Exposition (Eisenbahn Fahrbetriebsmittel auf der Aussfellung in Düsseldorf 1902). Berthold Braun. Giving illustrated descriptions of cars for steam and electric railways exhibited at Düsseldorf. 6000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Dec. 26, 1902. No. 53224 B.

Safety Device.

New Safety Device for Railways. Illustrates and describes the construction and method of operation of an electric device for preventing collisions. 1000 w. U S Cons Repts, No. 1543—Jan. 13, 1903. No. 52778 D.

Spark Arrester.

The Development of the Locomotive Spark Arrester. J. Snowden Bell. Considers the leading and characteristic features of the development. Ill. 2200 w. Loc Engng—Jan., 1903. No. 52741 C.

Train Lighting.

Steam Dynamo for Electric Train Lighting (Versuche mit einer Dampf-dynamo für Elektrische Beleuchtung von Eisenbahnzugen). A description of the Schichau-Schuckert machine, a small generating set placed on the locomotive, operating in connection with a storage battery. 1000 w. Glasers Annalen—Dec. 15, 1902. No. 53227 D.

Systems of Electric Train Lighting (Einige Systeme Elektrischer Zugbeleuchtung). Hans Dominik. Describing especially the systems of Vicarino and of Kull, using dynamos driven from the car axle. 3000 w. Ill. Zeitschr f Klein a Strassenbahnwesen—Jan. 1, 1903. No. 53286 D.

PERMANENT WAY & BUILDINGS.

Cattle-Guards.

The Cattle-Guard Question in Canada. Gives the conditions to regulate the types of guard, submitted by a specially appointed commission, and the changes proposed in location and arrangements. 1100 w. Ry & Engng Rev.—Jan. 3, 1903. No. 52869.

Grades.

Virtual Grades for Freight Trains. Discussion of a paper by A. C. Dennis. 2800 w. Pro Am Soc of Civ Engrs—Dec. 1902. No. 52633 E.

Oregon Short Line.

Improvements on the Oregon Short Line. Illustrated account of important new construction on this branch of the Union Pacific system. 1400 w. Ry Age—Dec. 26, 1902. No. 52754.

Rutland—Canadian.

The Rutland-Canadian Railway and Its Structures. John W. Burke. Illustrated description of this section of the Rutland R. R., its bridges, culverts, lake embankments, etc. 2800 w. Eng News—Jan. 15, 1903. No. 53050.

Shops.

New Locomotive Shops. The present article gives an illustrated general description of the new shops of the Philadelphia & Reading Ry., at Reading, Pa. 1600 w. Am Engr & R R Jour—Jan., 1903. Serial. 1st part. No. 52853 C.

Signals.

A Study of Some Interlocking Switch Systems. (Etude de Quelques Appareils Destinés à ne Libérer les Enclenchements qu' apres l'Achèvement des Mouvements). MM. Cossmann & Cuny. A description of the improved electrically operated interlocking system used in the train yard of the Gare du Nord at Paris. 6000 w. 2 plates. Rev Gen des Chem de Fer—Jan., 1903. No. 53231 H.

Pneumatic Signalling on the London and South-Western Railway. Illustrates and describes a plant on the low-pressure pneumatic system at Salisbury. 1500 w. Engr, Lond—Dec. 19, 1902. No. 52698 A.

Railway Block Signalling. J. Pigg. A well-illustrated paper, read before the Newcastle section of the Institution of Electrical Engineers, on block signalling, with particular reference to British practice. 7000 w. Elec Engr, Lond, (Supplement)—Jan. 2, 1903. No. 52821 A.

Recent Development of Block and Interlocking Signal System. W. H. Elliott. A review of recent changes made both from the standpoint of the trainmen, and from the standpoint of the signal engineer. 2000 w. Loc Engng—Jan., 1903. No. 52742 C.

Terminals.

Grand Central Station Improvements and Connection with Rapid Transit Subway. Brief illustrated account of the extensive improvements proposed for this terminal in New York, and of the Park Ave. tunnel. 1200 w. Sci Am—Jan. 17, 1903. No. 53044.

The New York Central's Terminal Proposition. An illustrated outline of the improvements suggested for the Park Ave. tunnel and a plan for the removal of a

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number of grade crossings. 1600 w. Ry Age—Dec. 19, 1902. No. 52750.

The New York Terminal of the Pennsylvania Railroad. Information from an official statement in regard to this proposed work. 1200 w. R R Gaz—Jan. 16, 1903. No. 53060.

TRAFFIC.

Per Diem.

The Operation of the Per Diem System of Settlement for Car Hire. Papers on this subject by M. B. Casey and by W. H. Rosevear, with discussion by members. 12300 w. N Y R R Club—Dec. 19, 1902. No. 52955.

Rates.

Legislative Regulation of Railroad Rates. Walker D. Hines. Presented at Philadelphia meeting of the Am. Econ. Assn. Discusses the question of enlarging the powers of the Interstate Commerce Commission by giving it the power to make rates and regulations for interstate traffic. 5400 w. Ry Age—Jan. 2, 1902. No. 52759.

Live Stock Rates Between Chicago and the Missouri River. A. B. Stickney. An argument made before the Interstate Commerce Commission in the case of the Chicago Live Stock Exchange vs. the A., T. & S. F. Ry. Co. and others. 14000 w. Ry Age—Jan. 23, 1903. No. 53141.

National Regulation of Railways. Charles A. Prouty. Abstract of a paper before the Philadelphia meeting of the Am. Econ. Assn. Suggests the creation of a commerce court and outlines the work belonging to it. 1300 w. Ry Age—Jan. 2, 1903. No. 52760.

Scientific Rate Making. Suggests a scheme of rate schedules. 2700 w. Ry Age—Dec. 26, 1902. No. 52753.

Senator Cullom on Pooling Legislation. From the Chicago *Tribune*. Considers that Congress has authority to grant the railroads permission to pool. 900 w. Ry Age—Jan. 2, 1903. No. 52761.

STREET AND ELECTRIC RAILWAYS

Accounting.

Street Railway Accounting. J. F. Calderwood. A discussion by different authors, of "Distribution of the Discount Credit," "Standard Form of Report," "Advantages of the Car Hour," and "Computation of the Loss from Transfers." 3500 w. St Ry Jour—Jan. 3, 1903. No. 53101 D.

Accumulator Traction.

Accumulators in Electric Traction. A discussion, with formulae, of the advantages of a combined accumulator and trolley or conduit system, the accumulators being charged on that part of the line equipped with wires, and driving the car the rest of the way. 1400 w. Elec Engr, Lond—Jan. 9, 1903. No. 53126 A.

Augusta & Aiken.

The Augusta & Aiken Railway. An illustrated description of a 25-mile trolley road in Georgia and South Carolina, and its electrical equipment. 3000 w. St Ry Jour—Jan. 3, 1903. No. 53023 D.

Birmingham, Ala.

New Car House and Repair Shops of the Birmingham Railway, Light & Power Co., Birmingham, Ala. Illustrated description. 2000 w. St Ry Rev—Jan. 20, 1903. No. 53075 C.

Brakes.

Brakes for Electric Tram Cars. A discussion of the ways tramcars may be braked and the requirements of an ideal brake. 2300 w. Engng—Dec. 19, 1902. No. 52683 A.

Chicago.

Engineering and Operating Features of the Chicago Transportation Problem. An abstract of the report submitted by Bion J. Arnold giving facts regarding the conditions and matters of engineering interest. 5500 w. St Ry Jour—Jan. 10, 1903. Serial. 1st part. No. 53040 D.

Report on Chicago Street Railways. Report of B. J. Arnold on the engineering and operating features of the transportation problem, submitted to the Committee on Local Transportation. Maps and ill. 11800 w. St Ry Rev—Jan. 20, 1903. No. 53074 C.

Commercial Management.

Some Notes on the Commercial Management of Electrical Tramways. T. W. Sheffield. A discussion of the advantages of electric traction, particularly in the Manchester district, the carriage of freight, interurban traffic, etc., with tabulated opinions of various British engineers. Serial. Part I. 2500 w. Feilden's Mag—Jan., 1903. No. 53118 B.

Control System.

Train Unit Control System Used on the Berlin Elevated Railway. A description with diagrams, of a system of electric train control, installed by Siemens & Halske, in which only two motor cars per train can be used. 1000 w. St Ry Jour—Jan. 3, 1903. No. 53024 D.

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Electric Cars.

Various Types of Cars for Electric Tramways (Different Types de Voitures Automotrices de Tramways Electriques). Gustave Lelarge. With illustrations of motors, controllers and trucks used on electric tramways in France. Serial. Part I. 10,000 w. 2 plates. Rev Gen des Chem de Fer—Jan., 1903. No. 53-232 H.

Electric Traction.

Electric Traction on Main Line Railways (Ueber Elektrische Zugförderung auf Normalen Eisenbahnen). Br. Böhm-Raffay. A discussion of the practicability of applying electric locomotives to main line service. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53-222 B.

Engineering Hints.

See Electrical Engineering, Generating Stations.

Europe.

The Possibilities for Capital in European Tramway Enterprises. A discussion of the features of urban and interurban passenger transportation in Europe, methods of obtaining franchises, and commercial possibilities of electric tramways. 5000 w. St Ry Jour—Jan. 3, 1903. No. 53022 D.

Fault Localising.

See Electrical Engineering, Measurement.

Freight.

Freight and Express. Alton D. Adams. Reasons why electric railways should take up freight and express business, with some statistics. 2500 w. St Ry Rev—Dec. 20, 1902. No. 53104 C.

Hydrocarbon Motors.

Applications of Hydrocarbon Motors to Traction Service (Anwendungen von Kohlenwasserstoffmotoren für Traktionszwecke). Illustrated description of internal combustion motors, using benzine or gasoline as fuel, in connection with tramway traction. 2000 w. Ill. Zeitschr f Klein u Strassenbahnwesen—Dec. 16, 1902. No. 53284 D.

Inclined Ry.

The Machinery for the Consett Iron Company's Garesfield and Derwenthaugh Inclined Railway. An illustrated description of the drum-house, drums, bed plate and brake gear. 1200 w. Ir & Coal Trds Rev—Dec. 26, 1902. No. 52-704 A.

Interurban.

Middleboro, Wareham & Buzzards Bay Street Ry. An illustrated description of an interurban road in the Cape Cod region, which is of interest because of its original schemes and ways of doing things. 6300 w. St Ry Rev—Jan. 20, 1903. No. 53073 C.

Kalgoorlie.

Electric Railway Construction in Kalgoorlie. Illustrated description of the system installed in this mining city of Western Australia. 600 w. St Ry Jour—Jan. 24, 1903. No. 53144 D.

Kingston.

Kingston Consolidated Railroad Company. An illustrated description of a successful trolley road at Kingston and Rondout, N. Y., and its park at Kingston Point. 2500 w. St Ry Jour—Dec. 27, 1902. No. 53019 D.

Lancashire.

The Electrification of South West Lancashire. Describes the Farnworth and Kearsley Tramways. Ill. 5500 w. Tram & Ry Wld—Dec. 11, 1902. No. 52706 B.

Line Car.

Line Car at Atlanta, Ga. Illustrated description of a construction and repair car for an electric railway. 700 w. St Ry Rev—Dec. 20, 1902. No. 53105 C.

Massachusetts.

Steam and Trolley in Massachusetts. Clarence Deming. Discusses the trolleys of this state and their bearing upon the steam roads, the railway laws, and the problems to be solved. 4000 w. R R Gaz—Jan. 16, 1903. No. 53057.

New Line.

The South Wales and Bristol Direct Railway. Information and description of the leading characteristics of this line. Ill. 2800 w. Transport—Jan. 2, 1903. No. 52930 A.

New York Traffic.

The Passenger Traffic Problems of Greater New York. W. W. Wheatly. Discusses existing conditions, the transportation problem, facilities under construction, the additional facilities as outlined, with suggestions for improvement. Ill. 5000 w. St Ry Jour—Jan. 10, 1903. Serial. 1st part. No. 53039 D.

Nottingham.

Nottingham Corporation Tramways. Illustrates and describes recent work in connection with these tramways, new sections, new sheds, and repair shops. 3800 w. Tram & Ry Wld—Dec. 11, 1902. No. 52705 B.

Ohio.

Engineering Features of the Western

We supply copies of these articles. See page 973.

Ohio Railway. D. W. Pell. An illustrated description of power house, line and cars of an interurban electric railway centering at Lima, Ohio. 2200 w. St Ry Rev—Dec. 20, 1902. No. 53107 C.

Outlook.

The Outlook in Electric Traction in 1903. Dr. Louis Bell. A general review of present conditions in electric tramways and railways. 1800 w. Elec Wld & Engr—Jan. 3, 1903. No. 52830.

Paris Conduit.

The Extensive Paris System of Conduit Electric Roads. C. L. Durand. An illustrated description of the track construction and other features of the Paris electric conduit railways. 1800 w. Elec Rev, N Y—Jan. 10, 1903. No. 53008.

Review.

Electric Traction in 1902. Dr. Louis Bell. A general review. 3000 w. Elec Rev, N Y—Jan. 10, 1903. No. 53001.

Rodez.

The Electric Tramways of Rodez (Les Tramways Electriques de Rodez). H. Somach. General description of overhead trolley line in operation at Rodez in the south of France. 1800 w. 1 plate. Génie Civil—Dec. 27, 1902. No. 53210 D.

Shops.

New Shops for the Chicago City Ry. Illustrated description of street railway shops and their equipment. 2500 w. St Ry Rev—Dec. 20, 1902. No. 53103 C.

Single Phase.

See Electrical Engineering, Power Applications.

Steam Car.

A Steam Propelled Street Car. An illustrated description of a self-propelled car being built for use in Yucatan, Mexico. 1200 w. St Ry Jour—Jan. 10, 1903. No. 53041 D.

Stopping.

The Cost of Stopping. R. W. Western. An examination of the expenses involved in the stoppage of tramcars. 2500 w. Tram & Ry Wld—Dec. 11, 1902. No. 52707 B.

Surface Contact.

The Cruvellier Surface Contact System. Illustrated description of the application of this system to long-distance traveling, with three-phase current at 3000 volts. 1300. Engng—Jan. 2, 1903. No. 52936 A.

Three-Wire.

A Three-Wire Electric Railway System Operating Between Grenoble and Chapareillan (France). Enrico Bignami. An illustrated description of an electric railway and hydro-electric station. Continuous current is distributed over a three-wire system, with 1,200 volts between the outer wires, and the car motors are in series. 1800 w. Elec Rev, N Y—Jan. 10, 1903. No. 53005.

Third Rail.

Results with the Third Rail in Boston. A report of the operation of this extensive system, the construction and the problems in its working. Ill. 1500 w. Elec Wld & Engr—Jan. 24, 1903. No. 53165.

Toledo & Western.

Equipment of the Toledo & Western Railway. An illustrated description of the track and line construction, rolling stock and power plant of this important interurban electric road in Ohio. 3500 w. St Ry Jour—Dec. 20, 1902. No. 53016 D.

Tri-City.

System and Parks of the Tri-City Railway Co. An illustrated description of an electric railway between Davenport, Iowa, and Rock Island and Moline, Illinois, and its pleasure parks. 2200 w. St Ry Rev—Dec. 20, 1902. No. 53108 C.

Trolley Poles.

The Manufacture of Iron Masts (Fortschritte in der Herstellung Eisener Rohrmaste). Emil Bock. A discussion of the stresses and strains upon tubular masts used for trolley and electric light wires, with description of improved machinery for making poles. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 3, 1903. No. 53204 D.

Trolley Wagons.

Electric Trolley Wagons and Omnibuses. Frank C. Perkins. Illustrates and describes a system of transportation gaining favor in French and German cities in streets where it is impossible to install tramways. 700 w. Sci Am—Jan. 3, 1903. No. 52772.

Trunk Lines.

Long-Distance Electric Railroading. Louis Duncan. Discusses the application of electricity to traction on tramways, suburban and interurban roads, and the field at present occupied by steam locomotives, reviewing the systems, and showing the methods now used are not applicable on steam roads, but thinks the problem will yet be solved. 3800 w. Tech Quar—Dec., 1902. No. 52949 E.

Vienna.

Plan for the Extension of the Vienna Municipal Railway (Ein Vorschlag zur Erweiterung des Wiener Stadtbahnnetzes). H. v. Feyrer. A study of the requirements of traffic upon the elevated railway of Vienna with a plan for extending the lines. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53223 B.

We supply copies of these articles. See page 973.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist & Metallurgist. *m.* London.

Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kl'k. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

City Transportation.

Report on the Engineering and Operating Features of the Chicago Transportation Problem Submitted to the Committee on Local Transportation of the Chicago City Council. By Bion Joseph Arnold, M. S., M. Ph., E. E. Size, 9¼ by 6¼ in.; pp. 310; figures, 50; folding plates, 15. Paper binding. Fourteen maps in separate cover.

The problems of local transportation are becoming more and more complex in our great cities and the need for their satisfactory solution is daily growing more urgent. It is therefore, highly encouraging to see these problems discussed in a scientific, yet practical way by an expert engineer, who is hard-headed enough to realize the force of existing conditions, but who also has the breadth of mind to take a general view of the situation and to provide for the future. The present report was called forth by the confused and congested condition of local transportation in Chicago, particularly in the business district, which is confined to an area of about one square mile, in which all traffic converges. The report devotes most attention to the surface railway systems, but it also presents a plan for a unified combined surface and subway system, and discusses the general transportation situation as well as many of the details, and it will well repay most careful consideration by all who are interested in the questions with which it deals.

Dies.

Dies: Their Construction and Use for the Modern Working of Sheet Metals. By Joseph V. Woodworth. Size, 9¼ by 6 in.; pp. 384; illustrations, 505. Price, $3. New York: Norman W. Henley & Co.

This is a treatise on the design, construction and use of dies, punches, tools, fixtures and devices, together with the manner in which they should be used in the power press for the cheap and rapid production of sheet metal parts and articles. It shows fundamental designs and gives practical points by which sheet metal parts may be produced at the minimum of cost and with the maximum of output. The hardening and tempering of press tools and the use of files are described, and many styles of power press are well illustrated. The classes of work which may be produced to the best advantage by the use of dies in the power press are discussed by one who speaks with the authority of experience, and the book as a whole is an eminently practical one, written by a practical man for practical men.

Illumination.

The Art of Illumination. By Louis Bell, Ph. D. Size, 9 by 6 in.; pp. 345; illustrations, 127. Price, $2.50. New York: McGraw Publishing Co.

As is well said in the opening paragraph of this volume, its purpose is "to set forth some of the fundamental doctrines, optical, physiological, and aesthetic, which underlie the proper use of artificial illuminants, and to point out how they may be advantageously adapted to existing conditions." While there has been a great deal written about the production of light in its mechanical and scientific aspects, there is very little literature on its distribution and consumption, to borrow analogies from economics. Illumination, or the useful effect of light, is, however, now receiving more attention, and it has been the subject of discussion before the American Institute of Electrical Engineers. In one of these recent discussions the author of the present book took a prominent part, and the matter which he so ably handled there, has now been elaborated and enlarged into a most interesting volume. The efforts of inventors and engineers have been mainly exerted in the production of an artificial light of high mechanical efficiency, and other considerations, of equal, if not greater practical importance in the art of illumination, have been too often lost sight of. The fundamental principles of illumination: that "it must be amply adequate in amount, suitable in kind, and applied so as not to react injuriously upon the eye," are clearly set forth in this book, and their applications very interestingly described and illustrated. The possibilities of vastly better illumination, even with our present sources of light, are well brought out, while at the same

time the author indicates the directions in which improvements in the sources of light themselves will probably be made.

Railway Statistics.

Fourteenth Annual Report on the Statistics of Railways in the United States for the Year Ending June 30, 1901. Prepared by Henry C. Adams, statistician to the Interstate Commerce Commission. Size, 9¼ by 6 in.; pp. 694. Map. Washington: Interstate Commerce Commission.

Among the most valuable results of the labors of the Interstate Commerce Commission are the statistics which are embodied in their reports, of which the present volume is the latest. Among the tables contained in the body of this report are those on the classification of railways and mileage; the amount of railway capital at the close of the year; earnings and income for the year; general expenditures; charges against income on account of railway capital, and general balance sheet. Preceding these tables is a discussion of them and also of other statistics concerning equipment, employees, public service of railways, taxes, accidents and various other matters. These reports are of the greatest importance for getting a correct understanding of the many and complex problems of the control and management of railways and, indeed, of other great corporations as well, and definite information such as this will help to determine to what extent the supervisory powers of the Interstate Commerce Commission may be applied to corporations other than railways, and how far the Government can advantageously carry its controlling functions without interfering harmfully with the efficiency and economy of individual management.

Steam Power Plants.

Steam Power Plants; Their Design and Construction. By Henry C. Meyer, Jr., M. E. Size, 9½ by 6 in.; pp. 160; illustrations, 65; plates, 16. Price, $2. New York: McGraw Publishing Co.

Part of the text of this volume appeared originally in *The Engineering Record* as a series of articles, which have now been thoroughly revised and have had considerable new matter added to them. The eleven chapters treat, respectively, of the design of steam power plants; proportioning steam boilers; design of tubular boilers and boiler specifications; selection of engines; specifications for steam engines; steam and water piping; condensers; feedwater heaters and economizers; mechanical draft; chimneys; coal handling, water supply and purification. The matter thus presented is of special value to owners or managers of manufacturing plants or buildings requiring power installations who are not themselves expert steam engineers, but who may be called upon to design or purchase a steam-power plant. Of course, the best procedure, under such circumstances, is to secure the services of a competent consulting engineer, but where this is not practicable, the present volume will be of great help in supplying sound information in a clear and attractive manner, and the expert himself will find in it many valuable facts and figures in accessible and convenient form.

Steam Turbine.

The Steam Turbine. By Robert M. Neilson. Size, 9 by 5½ in.; pp. 163; illustrations, 145; plates, 9. Price, 7s. 6d. ($2.50). London, New York and Bombay: Longmans, Green, and Co.

The steam turbine has lately come to the front with a rush. Although farsighted engineers have long recognized its possibilities and been impressed by some of its performances, to the general public and indeed, to the bulk of the engineering profession, it has been little more than a curious machine for propelling some small experimental vessel at phenomenal speeds. But now the merits of the steam turbine and its suitability for many purposes, on land as well as at sea, notably in driving electric generators, are becoming generally acknowledged, and it is eminently proper that there should be a book devoted to it, as its literature has heretofore been scattered through the pages of technical journals and the transactions of engineering societies. The present volume gives a general history of the steam turbine, traces the points of resemblance between it and other motors, discusses thermodynamic theory and some of the practical details of construction, describes the principal types of steam turbines in commercial use, gives the results of recent tests and tells of the application of the steam turbine to the propulsion of vessels. An appendix contains a list of the British patents relating to steam turbines from the earliest records up to the end of 1899, and an index completes a book which is timely, instructive and interesting.

BOOKS ANNOUNCED.

Design of Dynamos. By Silvanus P. Thompson, D. Sc., F. R. S. Price, 12s. 6d. ($3.50). New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

Hardening, Tempering, Annealing and Forging of Steel. By Joseph W. Woodworth. Price, $2.50. New York: Norman W. Henley & Co.

A Treatise on Roads and Pavements. By Ira Osborn Baker, C. E. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

An Elementary Treatise on the Mechanics of Machinery. By Joseph N. Le Conte. Price. $2.25. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

NEWS SUPPLEMENT

The Engineering Magazine—March, 1903

Coming Society Meetings.

AIR-BRAKE ASSOCIATION. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting, April 28, Colorado Springs.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meeting on fourth Friday of each month, 12 W. 31st St., New York. March 27: Papers on "High Tension Lines."

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Meeting, April 22, 1903, New York.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 17 and 18, Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22, etc., Mackinac Island, Mich.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting. June, at Saratoga.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Patterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except January, when on fourth Wednesday.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: H. M. Jones, 1000 Broad St., Nashville, Tenn. Regular meetings on second Thursday of each month at Vanderbilt University.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Thursday of each month.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall. Buffalo. Regular meetings, first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month. Regular monthly meetings of the various sections on other days.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on the second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting June 17, etc. Mackinac Island, Mich.

MODERN SCIENCE CLUB. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

MONTANA SOCIETY OF ENGINEERS. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: James B. Cahoon, 136 Liberty St., New York. Meeting, May, Chicago.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, at Pierce Hall, Copley Square.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, N. Y. C. & H. R. R. R. Regular meetings on third Friday of each month except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, alternating between Minneapolis and St. Paul.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month, at San Francisco.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURGH. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburgh, Pa. Regular meetings on fourth Friday of each month at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: B. B. Adams, 32 Park Place, New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting Nov. 10, at Detroit.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: Chas. McEniry. Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Fridays.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th Street.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TRAVELING ENGINEERS' ASSOCIATION. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month.

Personal.

—Mr. Alexander C. Humphreys was inaugurated president of Stevens Institute of Technology, at Hoboken, N. J., on February 5th.

—Mr. Henry C. Meyer, Jr., M. E., who formerly conducted the *Engineering Record*, and who is now acting as consulting mechanical engineer, has removed from 21 Park Row to 114 Liberty Street, New York.

—Mr. Louis Ruprecht, M. E., has opened an office at 19 Whitehall St., New York, where he is doing consulting engineering work. He also has the agency for the New York Steam Fitting Co.

—Mr. George H. Gibson has resigned his position with the Westinghouse Companies' Publishing Department of Pittsburg, Pa., to accept a position with the B. F. Sturtevant Company, of Jamaica Plain Station, Boston, Mass., the well-known manufacturers of blowers, heating, ventilating and forced-draft apparatus, electrical machinery, and steam engines. Mr. Gibson was formerly a member of the editorial staff of the *Engineering News*, of New York City, and is a graduate of the Engineering School of the University of Michigan.

—Mr. J. A. Middleton has been elected second vice-president of the Lehigh Valley R. R. Co., with office at 228 South Third St., Philadelphia, Pa. He will have charge of the financial and accounting affairs of the company and of its purchasing department, and will perform such other duties as may, from time to time, be assigned to him by the president.

—Mr. John Wharton Maxcy, who has had charge of much of the important engineering work in the southwestern section of the United States, and Mr. William E. Anderson, who was, for a number of years, mechanical engineer for the American Cotton Company, have formed the firm of Maxcy & Anderson, civil and mechanical engineers, to do a general consulting en-

gineering business, and especially the engineering of irrigation plants, of which a great many are being built in Texas and Louisiana.

—Mr. W. S. Chase, formerly treasurer of The Cleveland Machine Screw Co., is now connected with the National Acme Manufacturing Co. in the capacity of sales manager. In his former position Mr. Chase formed a wide acquaintance with the automatic screw machine trade of the country, and he will be glad to hear from his old friends and the trade generally in this line.

—Mr. William H. Bryan, M. E., recently delivered a lecture before the Washington University Association, of St. Louis, on "The Mechanical Engineer: His Duties, Responsibilities and Opportunities."

—Mr. J. R. Bibbins, of the Westinghouse Companies' Publishing Department, Maritime Building, New York, delivered an interesting and comprehensive address at the last annual banquet of the New York Physics Club upon the subject of "Recent Developments and Use of Electric Power." The address closely followed the subjective topics of systems and appliances, power development, high tension transmission, and electric traction, and briefly treated of the conditions leading up to, and the present trend of modern engineering practice in the field of power utilization. Late inventions were also touched upon in the address, prominent among them being the Hewitt vapor lamp and converter, and recent single phase traction systems.

Industrial Notes.

—The United States Government has ordered, within a year, 1,500,000 square feet of Ruberoid roofing for use in the Philippines. This quantity would make a single 36-inch strip over 100 miles long. The last order was for a million square feet and was placed with the manufacturers, the Standard Paint Co., of 100 William St., New York, at a price which was 16 per cent. higher than the highest bid for other roofings, thus proving that the government recognizes the superiority of Ruberoid, and considers it economical at any price.

—J. Jacob Shannon & Co., of 1744 Market St., Philadelphia, have issued a very convenient and attractive diary for 1903, which, among its other interesting and valuable features, carries with it an accident insurance policy for $100, good for one year. There has been such a demand for this diary, that the first edition has been exhausted, but a second edition is being brought out, and those desiring a copy should apply without delay to Mr. Leon Rosenbaum, of the above firm.

—M. H. Treadwell & Co., of 95 Liberty Street, New York, the well-known manufacturers of all kinds of special machinery, are distributing among their friends a very neat souvenir, in the form of a thin steel pocket foot-rule, in a leather case.

—The Keuffel & Esser Co., of New York, the well-known manufacturers and importers of drawing materials, mathematical and surveying instruments, have just issued a handsome new catalogue, printed in colors, which contains many additions to those previously published.

—The Power Specialty Company have been awarded a contract by the New York Central & Hudson River Railroad for four superheaters to be installed in four 500-horse-power Aultman & Taylor boilers at the new Weehawken power house, and have also received an order for superheaters from the Kentucky Refining Co.

—The Dayton Globe Iron Works, of Dayton, Ohio, have recently arranged with the Pelton Water Wheel Co., of 125 Main St., San Francisco, to represent them on the Pacific Coast, and have given the Pelton Co. the exclusive sale of the New American turbine water wheel in that region.

—The business and affairs of the Q & C Company have been consolidated with those of the Railway Appliances Company, and will be conducted under the name of the Railway Appliances Company. All correspondence and remittances should be in the name of the Railway Appliances Company. This consolidation allows greater facilities in the conduct of this business, increasing the lines of devices, while retaining in the new company the individuals heretofore connected with the Q & C Company.

—The Pedrick & Ayer Company, which for a great many years have been located at Philadelphia, Pa., have removed to Plainfield, New Jersey, and are now occupying their new works which they have just completed, the main building of which is four hundred feet long and one hundred feet

wide, with independent power-house, blacksmith shop, pattern shop and pattern storage. This new shop has been equipped with electric traveling cranes and modern tools so as to enable the Pedrick & Ayer Co. to meet the largely increased demand for the standard goods which they manufacture and for which they have made such a reputation, consisting of air compressors, air hoists, pneumatic riveters and special railroad tools. Their selling office is at 85-87-89 Liberty Street, New York City.

—The Vulcan Iron Works Co. have issued a business-like and interesting calendar for 1903, adorned with pictures of their well-known "Giant" and "Little Giant" steam shovels. One of these illustrations represents a 65-ton steam shovel loading into a Goodwin car, thus showing the height this "Giant C" shovel can raise the dipper and dump into a car.

—The General Fire Extinguisher Co., of Providence, R. I., successors to the Providence Steam and Gas Pipe Co., have recently enlarged their factory and are better equipped than ever for the manufacture of their special high-grade fittings, valves, etc.

—The Lagonda Mfg. Co., of Springfield, Ohio, have just issued an attractive and handsome little circular entitled "Let's talk it over," which they will be pleased to send to anyone interested in tube cleaners or feed-water regulators.

—The "Bitulithic Pavement" otherwise known as "Warren's Patent Bituminous Macadam Waterproof Pavement," has met with the approval of taxpayers and practical engineers in such a degree that during the past year it has been adopted and contracted for in forty-four American cities to the extent of over 800,000 square yards. The Warren Brothers Company, which manufactures this pavement, is composed of practical men, who have grown up with, and devoted their entire business lives to, the development of the bituminous pavement industry, having held positions of importance in the practical departments of several of the largest asphalt paving companies. The members of Warren Brothers Company have had direct charge of the laying of over one-third of the asphalt pavement of the United States and Canada. They appreciated the weak points of the old asphalt pavement, and the "Bitulithic Pavement" is the result of their combined energy and scientific study. It is not an experiment but a development in the industry, and not only provides scientifically accurate means to give uniformly the results which were attained occasionally by haphazard methods in the laying of pavements thirty years old and still in good condition, but in many details improves on the older pavements.

—The H. H. Franklin Manufacturing Co., of Syracuse, N. Y., producers of finished castings, have just erected a new building, 52 feet by 110 feet, five stories in height. The plant for generating electricity for power and light will be separate from the main building, and current will be conducted through a subway to the lower part of the latter and thence to motors on every floor. A wing contains the elevator, stairs and lavatories, so that every floor of the main portion of the building is intact, and does not have any holes. The building will be heated with exhaust steam by the fan system, fresh air being taken from outside for ventilating purposes. This company manufactures castings which do not require finishing. All the features are accurate, smooth and sharp. These castings have all the characteristics of machined pieces, and at the same time, are far lower in price. As an example, 22,000 small gears are now being made for one customer, the former cost of each of which for milling alone was 18 cents. Cast finished in hard metal they now cost only 12 cents complete.

—Users of power machinery run no risk whatever in trying Graton & Knight's "Royal Worcester" and "Heart" brands belts. The makers, the Graton & Knight Mfg. Co., of Worcester, Mass., offer these belts solely on their ability to transmit power more economically than any other make, and in order to push their claims to the limit, agree to send a belt to any reliable manufacturer to test in his own way, and if it is not found to be the most economical belt to use, it may be returned free of cost and full credit will be given. The users of machinery will do well to write to the Graton & Knight Mfg. Co. and learn about the full text of their proposition.

—The late Spanish-American war seems to have impressed upon the engineers of the Spanish government the need of adopting the most modern methods in the

manufacture of munitions of war. They are installing Westinghouse motors in their gun shops at Trubia, and the Spanish arsenal at Ferrol is also shortly to be equipped with a number of motors and other electrical machinery.

—The enterprising Japanese realize the benefits that result from placing before their own people the evidences of their achievements in arts and manufactures, and therefore organize national exhibitions, far enough apart in time to enable the visitor to note the progress made, and held in different parts of the empire, in order that all of the inhabitants may sooner or later enjoy the satisfaction of seeing at least one of the series. This year, the Fifth National Industrial Exhibition will be held in Osaka, a city of 300,000 people, from March 1st to July 31st. Here will be installed in a dozen or more buildings the largest collection of exhibits ever shown in Japan. The floor surface thus occupied will be twice that employed at the last exhibition, held seven years ago at Kioto. In addition to native products, there will be many articles from China and not a few from Europe and America. The greatest good will come to those who are seeking trade with Japan, since it will afford them an opportunity to ascertain in the shortest possible time the nature of the needs of the country and the extent to which these wants are being supplied by local concerns. Because of the position now held by the United States in the East, and especially since we are next-door neighbors to Japan, there is in that country a natural desire to trade with us, but it is expected that we should seek that trade and begin by ascertaining its character and extent. Several American firms are exhibiting at this exhibition in a pavilion erected for foreign exhibits, but those who found themselves too busy to prepare an exhibit, can profit by sending representatives to report on trade conditions so that when exports to other countries grow less, they may know where new markets may be created.

—The Philadelphia Pneumatic Tool Co. reports that its sales for December exceeded those of any other month but one in its history. The business outlook for the current year is very bright and a number of large orders for pneumatic tools that had been held over until after the first of the year, have already been received and executed by this company. A very gratifying feature of the Philadelphia Company's business is the large increase in railroad trade during the last six months of 1902, not only in the United States, but in Canada and Mexico as well. With its recently greatly increased facilities, this company expects to double its last year's business during the current year. The Philadelphia Pneumatic Tool Co. is an independent company having no connection or working agreement with any other concern whatever.

—At a meeting of the Board of Directors of the Allis-Chalmers Company, held January 15th, 1903, a regular quarterly dividend on preferred stock was declared.

—The Sheet Metal Mfg. Co. of Niles has just been awarded the contract for the metal ceilings throughout the entire 14 stories of the new Benton block in New York City. The designs are said to be the handsomest ever submitted for this class of work, and it will take one year to complete the contract.

—The Register of Lehigh University, South Bethlehem, Pa., just issued, shows the attendance of 581 students, from 27 states and 6 foreign countries. There are 52 in the teaching staff. Twelve courses of instruction are offered at the university: the Classical Course, the Latin-Scientific Course, courses in Civil, Mechanical, Metallurgical, Mining, Electrical, and Chemical Engineering, Analytical Chemistry, Geology, Physics and Electro-Metallurgy. A list of the graduates of the university, 1,248 in number during the 37 years of its existence, indicates that this institution is exerting a very marked influence on the industrial development of the United States, and also of foreign countries. The following prize scholarships will be open to competition at the annual examinations in June: Two in the Classical Course at $150 and $100 each and one in the Latin-Scientific Course of $125 annually in addition to free tuition. Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

—H. B. Underwood & Co., the manufacturers of special tools for railway repair shops, are just finishing up a portable crank-pin-turning machine large enough to turn

off pins (in position) up to 15 inches in diameter by 15 inches in length. It is believed that this is the largest portable crank-pin-turning machine ever built; it was made on the same lines as the Underwood Co.'s regular crank-pin-turning machine.

—The Equitable Building, Boston, which was partially destroyed by fire on January 9th, will be entirely rewired by Sargent, Conant & Co., the electrical engineers and contractors of that city, who had a crew of men at work making temporary connections within twenty minutes after the fire was under control. As an example of modern commercial methods it may be noted that this company, whose old offices were entirely gutted, was transacting business in new quarters with a complete office equipment, telephone service, etc., in less than twenty-four hours after the fire was extinguished.

—W. O. Duntley, vice-president of the Chicago Pneumatic Tool Company, recently went on a trip to the Pacific Coast in the interests of the company. His trip extended over a period of several weeks and was a remarkably successful one as regards sales of pneumatic machinery. The prosperity of the company still continues and the orders for pneumatic appliances of every description are steadily coming in. The amount of business transacted for January was double that transacted for the same period of time last year. This increase in orders is causing their factories to work both night and day. Especially is this noticeable in their air-compressor plant at Franklin, Pa., where the facilities are taxed to their utmost in order to fulfill the orders for air compressors received.

—The Steam Boiler Equipment Company of New York has increased the number of its directors from three to seven, as follows: Hon. Wm. McAdoo, formerly Assistant Secretary United States Navy; David C. Reed, President Harlan & Hollingsworth Co., Wilmington, Del.; Col. R. H. Hunt, of Kansas City, Mo., of which city he was formerly mayor; Olin F. Gleason, President E. P. Gleason Mfg. Co., New York; W. B. Wilkinson; Dr. P. J. Oettinger, of New York; E. H. Hovey, New York. The Risdon Iron & Locomotive Works, the Pacific Coast representatives of this company, have received their fifth order from the Oceanic Steamship Company, this being for the S. S. "Sonoma," built by the Wm. Cramp & Sons Co. The fourth order was for the "Zealandia," which, though twenty-seven years old, made the fastest trip of her history after being equipped with the "Hydro-Carbon" system.

—The Pittsburgh Gage & Supply Co., Pittsburgh, Pa., is equipping two 3,000-H. P. Allis engines of the Pittsburgh Steel Co., Monessen, Pa., plant with the White Star continuous oiling systems. Other contracts are the equipping of three 400-H. P. engines for the Clairton Steel Co., Clairton, Pa., and six 500-H. P. engines in the electric light and power plant of the Union Depot, Pittsburgh, Pa., for the Pennsylvania Railroad Co. The Pittsburgh Gage & Supply Co. is also furnishing systems for Swift & Co., Ft. Worth, Texas, Seere & Co., Moline, Ill., and the Amherst Gas Co., Amherst, Mass.

—The W. Dewees Wood Company Department of the American Sheet Steel Co., McKeesport, Pa., have contracted with Wm. B. Scaife & Sons Co., of Pittsburg, Pa., for a 5,000 H. P., We-Fu-Go water softening and purifying system. This plant, in addition to supply the boilers with pure water, freed from the sulphuric acid, with which the Monongahela river water is impregnated, is to supply water used in the process of manufacturing some of the finer grades of sheet iron. Sulphuric acid has always been the bugbear of steam users, where this kind of water had to be used in boilers. The We-Fu-Go system has been used for a number of years for removing the free acid, as well as any scale-forming substances present in water, with perfect success. This is the third contract placed with Wm. B. Scaife & Sons Co., by the American Sheet Steel Co. during the last four years for a water softening and purifying system. Those already in operation are giving perfect satisfaction. Among some of the other contracts taken by Wm. B. Scaife & Sons Co., of Pittsburg, Pa., for both the We-Fu-Go and Scaife systems, are the following: Republic Iron & Steel Co., East St. Louis, Ill., 2750 H. P.; Salem Iron Co., Lestonia, O., 2500 H. P.; Buffalo & Susquehanna Iron Co., Buffalo, N. Y., 8000 H. P.; Rochester & Pittsburg Coal & Iron Co., Dubois, Pa., 2500 H. P.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue with illustrations and descriptions of various types and special designs of air compressors, their parts and accessory apparatus. 9 by 6 in.; pp. 72. Also, catalogue of compressed-air rock drills, mountings and appurtenances. 9 by 6 in.; pp. 63. McKiernan Drill Co., New York.

Brass Goods.

Illustrated catalogue and price list of stamped brass goods such as hinges, box corners, ring pulls, handles, card and label holders, and other kinds of brass and metal goods, including wire nails and escutcheon pins. 10¼ by 7½ in.; pp. 36. L. F. Grammes & Sons, Allentown, Pa.

Boilers.

Cloth-bound book, with illustrations and descriptions of the Cahall water-tube steam boilers, their parts, their method of manufacture, plants where they are installed, and results of tests. Also, illustrated description of the Mansfield chain-grate, mechanical stoker. 6 by 9 in.; pp. 120. Cahall Sales Department, Pittsburg.

Bridges.

"From Steelton to Mandalay," an elaborately illustrated pamphlet, giving a description of the Gokteik Viaduct, in Burma, 2,260 feet long and 320 feet high, and an account of its manufacture, shipment and erection in a remarkably short time. 6¾ by 9 in.; pp. 40. Pennsylvania Steel Co., Steelton, Pa.

Cranes.

Catalogue No. 15, with illustrated descriptions of a large variety of cranes of various types, among the most prominent being three, four and five-motor electric traveling cranes of capacities of from 3 to 50 tons, hand-power traveling cranes, jib cranes and locomotive cranes of standard design. 6 by 9 in.; pp. 48. Northern Engineering Works, Detroit.

Crushing Machinery.

Catalogue A, fourth edition, with illustrations and descriptions of ore and rock-crushing machinery, revolving screens, elevators, conveyors, etc., manufactured by the Farrel Foundry and Machine Co., and views of crushing plants. 10 by 7½ in.; pp. 62. Earle C. Bacon, Engineer, Havemeyer Building, New York.

Drop Forgings.

Catalogue, with illustrations, descriptions and price lists of wrenches, lathe dogs, hooks, eye bolts, sockets, crank shafts and many other kinds of drop forgings in iron, steel, copper, bronze and aluminum. 7 by 4½ in.; pp. 93. J. H. Williams & Co., Brooklyn, N. Y.

Electric Mining Machinery.

Catalogue "F," with fully-illustrated descriptions of electric mining machinery, including breast machines, long-wall machines, electric locomotives, both third-rail and trolley, hoists, pumps, larries, etc., their details and accessories. 6½ by 9½ in.; pp. 80. Goodman Manufacturing Co., Chicago.

Electric Rock Drills.

Catalogue C, describing and illustrating electric percussion rock drills for mining, tunneling and quarrying, and the generators which supply them with current, all of which are of simple, strong and rugged construction. 6 by 8¾ in.; pp. 31. Marvin Electric Drill Co., Binghamton, N. Y.

Feed-Water Heaters.

Pamphlet with illustrated descriptions of the Pittsburgh feed-water heaters and purifiers, comprising the open and closed (tubular) types, of the combined heater and receiver, and of their details. 9 by 6 in.; pp. 44. The Pittsburgh Feed Water Heater Co., Pittsburgh.

Fireproof System.

Pamphlet with illustrations and descriptions of the Columbian system of fireproofing, which consists in forming a monolithic floor with ribbed steel bars and concrete, and of tests of this system of construction. Also, a list and views of buildings where it is used. 10 by 5½ in.; pp. 79. Columbian Fireproofing Co., Pittsburg.

Foundry Equipment.

Catalogue No. 11, with illustrations, descriptions and prices of a most complete line of equipment and supplies for iron, steel and brass foundries. 6 by 4 in.; pp. 372. J. W. Paxson Co., Philadelphia.

Gas Engines.

Illustrated pamphlet, devoted to the Nash gas and gasoline engines. Single, double and three-cylinder engines are shown and described in detail, special attention being given to direct-connected sets for electric lighting and gas-engine and triplex-pump combinations for water-works and other pumping service. There are also views of plants, tables of standard sizes, figures as to cost of operation, and other useful information. 6 by 9 in.; pp. 43. National Meter Co., New York.

Gasoline Engines.

Pamphlet with illustrated descriptions of National Junior gasoline engines, strongly and simply built in small sizes, for pumping and general power work. 6 by 3½ in.; pp. 11. Wolcott Windmill Co., Saginaw, Mich.

Governor.

Folder, with illustration and description of the Woodward friction water-wheel governor, size B, compensating type, horizontal model, for regulating the speed of turbines by moving their gates. 9 by 6 in.; pp. 4. Woodward Governor Co., Rockford, Ill.

Keyseating Machine.

Pamphlet No. 35, with illustrated description of a double-spindle milling machine for keyseating shafting, which produces entirely the same results as a cotter drilling machine, and in far less time. Also, illustrations of many other varieties of machine tools. 9 by 6 in.; pp. 8. Newton Machine Tool Works (Incorporated), Philadelphia.

Locomotive Headlight.

Pamphlet with illustrations and descriptions of the Rushmore lens mirror locomotive headlight, which is a projector having an aplanatic glass mirror and using an acetylene flame. The acetylene generator is also shown and described. 9¼ by 6 in.; pp. 15. Rushmore Dynamo Works, Jersey City, N. J.

Molding Machines.

Catalogue with illustrated descriptions of molding machines in all sizes and styles, so as to be specially adapted to any class of work, and of pneumatic sand rammers. 6 by 8¾ in.; pp. 31. Maywood Foundry & Machine Co., Maywood, Ill.

Multiple Control.

Special publication No. W. A. B. 7,000, a pamphlet illustrating and describing the Westinghouse electro-pneumatic system for controlling railway and other motors. 6¼ by 9 in.; pp. 15. Also, book of instructions for the operation and inspection of the Westinghouse multiple train control system for electric railways. 7¾ by 5½ in.; pp. 19. The Westinghouse Air Brake Co., Pittsburg.

Overhead Tramrail Systems.

Catalogue with illustrations and descriptions of the Moyer overhead tramrail system, its details and applications, the Moyer "ham-tree" system for packing houses, etc., traveling cranes, and other elevating and conveying machinery. 9 by 6 in.; pp. 144. J. W. Moyer & Co., Philadelphia.

Phosphor-Bronze.

Revised price list No. 21, of the "Elephant" brand of phosphor-bronze, in rolls, sheets, wire, rods, ingots, castings, and other forms, and for various uses, with descriptions of this alloy and useful tables. 6 by 3½ in.; pp. 19. The Phosphor-Bronze Smelting Co., Philadelphia.

Pneumatic Tools.

Pamphlet on "The Care and Use of Pneumatic Tools," giving illustrated directions for their proper operation, with special reference to the Keller tools. 9 by 6 in.; pp. 8. Also, pamphlet with illustrations and descriptions of the Keller pneumatic tampers for use on copper converters and steel converters. 11 by 8½ in.; pp. 5. Philadelphia Pneumatic Tool Co., Philadelphia.

Rolling Mills.

Large, illustrated catalogue of Aetna rolling-mill engines, Aetna Corliss engines, furnace chargers, shears, rolls and pinions, roller tables, lathes and special machinery, and other kinds of rolling-mill and tin-mill machinery. 7¾ by 11 in.; pp. 116. Geo. A. Hogg Iron & Steel Foundry Co., Pittsburg.

Scales.

Catalogue with illustrations and descriptions of the Richardson automatic weighing machines, which are operated entirely by gravity, and in which the material is weighed, registered and discharged automatically. These scales are now in use weighing coal, grain, flour, cement, sugar and many other materials, in large and small charges. 9 by 6 in.; pp. 25. Richardson Scale Co., Park Row Building, New York.

Steam Apparatus.

Illustrated catalogue, seventh edition, with descriptions and prices of injectors, condensers, vacuum breakers, steam jet apparatus, blowers, siphons, exhausters, pipe, globe, angle and check valves, and many other kinds of machinery, appliances and attachments for steam plants. Also, all kinds of bronze and brass castings and other work. 9 by 6 in.; pp. 128. The Eynon-Evans Mfg. Co., Philadelphia.

Stokers.

Pamphlet entitled "The Evolution of the Jones Under-Feed Stoker," containing a reprint of a paper read before the New England Cotton Manufacturers' Association, by George C. Tewksbury, describing and illustrating this mechanical stoker. 9½ by 6¼ in.; pp. 19. The Under-Feed Stoker Co. of America, Chicago.

Surveying Instruments.

Catalogue, nineteenth edition, with illustrated descriptions and prices of transits, levels, solar compasses, solar transits, plane tables, self-reading level rod, goniometer, tapes, track inspection and registering instrument, gradienter and other attachments, and other instruments, together with the principles, methods and performance of adjustments of engineering instruments, and description of stadia and gradienter work, with diagrams and tables for finding the difference of level by these methods. 9 by 6 in.; pp. 140. Young & Sons, Philadelphia.

Testing Machinery.

Catalogue with illustrations and descriptions of testing machines for tensile, compression, torsion, transverse, impact, oil and friction, and other kinds of tests, in sizes ranging up to 400,000 pounds capacity, and of many details and accessories. 10½ by 8½ in.; pp. 71. Tinius Olsen & Co., Philadelphia.

Thread-Milling Machine.

Pamphlet, with well-illustrated descriptions of thread-milling machines for the highest and most precise class of work, which, besides possessing practically all of the flexibility and adaptability of the ordinary engine lathe, do the work at a fraction of the cost. Also, specifications and tables of useful data. 9 by 6 in.; pp. 42. Pratt & Whitney Co., Hartford, Conn.

Transits.

Pamphlet, with illustrated description of the Buff precise transit, and view of the shop where it and other precise engineering instruments are manufactured. 7¾ by 5¼ in.; pp. 4. Buff & Buff Manufacturing Co., Jamaica Plain, Boston, Mass.

IMPROVED MACHINERY

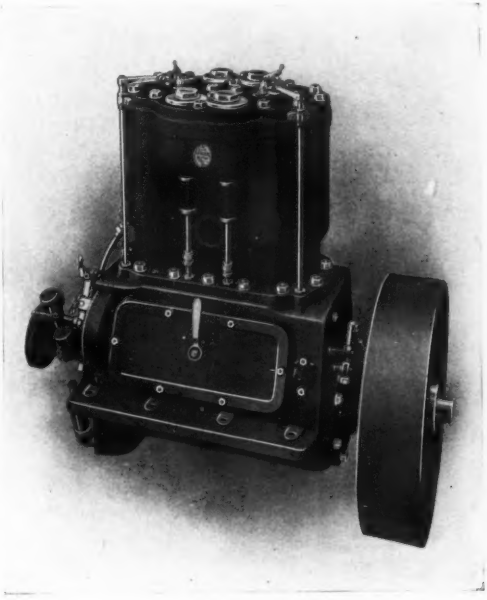
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Four-Cycle Marine Engine.

THE Lozier 18-H. P. four-cycle marine engine embodies many late improved ideas in marine-gas-engine construction, and possesses many features of merit probably not combined in any other form or make of engine.

One striking feature noted in this motor in comparison with other makes is the fact that all parts needing attention are very accessible, and at the same time this feature is combined with a very prepossessing outside appearance. These engines are neither of the extremely high-speed type, with their accompanying vibration and excessive wear on all working parts, nor of the heavy, cumbersome, slow-speed type, but an up-to-date mean between the two.



LOZIER FOUR-CYCLE MARINE ENGINE.

The inlet and exhaust valves are of the same size, a point which is of obvious value, and all valves are mechanically lifted, which feature renders them absolutely certain and practically noiseless in action, and also obviates the trouble of sticking and fouling which is liable to occur in the type of valves operated by suction. The engine is so designed that any valve may be removed by simply unscrewing the cover which is set in the head over it without removing any of the piping connected with the engine. The ignition mechanism is very simple and of the "hammer-break" type. The firing plugs occupy a central position in the cylinder head and may be easily removed and the sparking joints or insulation easily examined. All valve chambers and other parts needing protection from the heat are well water-jacketed by the same form of rotary pump used in the Lozier two-cycle engines. The rotary pump has proved to be preferable to the reciprocating type on account of its greater simplicity, absence of valves, and the larger supply of water delivered. The pump is in a very accessible position and is driven by a chain. The water is conducted from one engine cylinder jacket to the other through a cored passage, doing away with the unsightly pipes observable in many other engines.

In this connection, the small amount of piping necessary for the installation of this

18-H. P. engine is noticeable. This point was borne in mind in designing the engine, and gives the motor a neat, clean-cut appearance, and makes the engine one which is an ornament to an engine-room rather than an unsightly object.

The system of oiling in these engines is a a marked improvement over the usual method, and instead of numerous oil cups, all requiring attention, two sight-feed oil cups take care of oiling the entire motor.

The governor is very simple and all its parts are accessible. The governor operates by varying the lift of the admission valve, which is superior to the ordinary method of throttling as it is always a valuable point to throttle the gases as close as possible to the cylinder. The governor is set to hold the engine at 18 horse power, and with the governor in action the engine will run steadily at full, half, or no load. In case of heavy seas where the screw is liable to come out of the water, the engine will run without racing, or without appreciable increase in speed. When under way and on long runs, the governor may be immediately disengaged by a small latch, and the engine will develop fully 20 horse power, the governor obviously being necessary only when stopping, reversing, making landings, and in heavy seas.

In addition to the automatic governor, there are several other means of controlling and regulating the engine mechanically. Instead of the ordinary relief valves with their consequent noise and admission of smoke and burnt oil into the engine-room, a small hand lever is employed, by means of which the exhaust valves can be lifted, relieving the compression and causing the engine to run slowly or the fly-wheel to be turned by hand with very little exertion.

For further regulation, a small hand lever conveniently placed at the front of the engine allows the position of the igniter cam shafts to be changed, causing a change in the time of ignition: and still another means of controlling the engine is furnished by means of a butterfly throttle between the vaporizer and inlet valves.

The material, construction and workmanship of this engine are of a very high grade. All connecting rod, cam shaft and crank shaft bearings are bronze-bushed, and the cams, governing parts, and valve mechanism are case-hardened, giving longer life with less friction.

The cylinder head is in one piece in both engines, and for convenience in lifting it there is a strong eye-bolt centrally placed.

The inlet and exhaust valves are on opposite sides of the engine with a slight but equal overhang, giving a very well balanced appearance to the motor. The engine and clutch are placed on an auxiliary iron bed-plate firmly screwed thereto, making the whole outfit self-contained. At the after end of this bed-plate is installed our ball-bearing thrust, adjustable for both forward and reverse thrust, which feature of adjustability is obtained on but few engines.

Further information concerning this interesting engine will be gladly given by the Lozier Motor Co., of Plattsburg, N. Y.

The "Wear Well" Hydraulic Leather Packings.

THE Detroit Leather Specialty Co., of Detroit, Michigan, is placing on the market a special hydraulic leather packing bearing the trade mark "Wear Well."

The leather is tanned specially for this company by one of the leading tanners in the United States, and has been subjected

"WEAR WELL" LEATHER PACKING.

to a pressure test of 5,000 pounds to the square inch.

The packings are formed by machines, which have been constructed especially for this class of work, so that the leather does not crack or tear in any way when subjected to a strain such as is necessary in forming up a U-shaped packing.

The cuts which are shown serve to illustrate some of the various styles that this company is manufacturing for hydraulic and compressed-air machinery.

The Detroit Leather Specialty Co. has

been eminently successful in assisting manufacturers who have experienced trouble in properly packing their machines, and if you send the officers of this company your

"WEAR WELL" LEATHER PACKING.

specifications they will take pleasure in submitting samples of a packing which they claim will last longer, show a greater efficiency and sustain a greater pressure than any other make yet produced.

Compound Air Compressor.

A NEW type of air compressor, built at the Franklin (Pa.) Air Compressor Works of the Chicago Pneumatic Tool Company is shown on page IV. This machine represents the latest product in this exacting field, and is designed to meet the growing demand for higher efficiency in air compression that naturally attends the steadily increasing adoption of pneumatic machinery, in all branches of industry. It is known as the Class C. S. C. pattern, designed for a delivery air pressure of 100 pounds per square inch, with a steam pressure of 100 to 150 pounds. The compressor illustrated has low-pressure steam cylinder 31 inches in diameter, high-pressure steam cylinder 20 inches in diameter, low-pressure air cylinder 28 inches in diameter, and high-pressure air cylinder 16½ inches in diameter, all cylinders being 24-inch stroke.

The capacity of the compressor is 1710 cubic feet of free air per minute when operated at 100 revolutions, or 2052 cubic feet at 120 revolutions.

In design, the frames follow the most approved Corliss construction and are of exceptional strength, to withstand extreme strains without producing mechanical distress. The steam and air cylinders are tied tandem to each other with heavy tie rods and are rigidly supported by a sole plate, which extends beneath all four cylinders. The pillow blocks have extra broad pedestals and all frames are planed perfectly true on the bottom, assuring a perfect alignment.

All cylinders are of extra close grain iron, with appropriate thickness for reboring, and are bored absolutely true and parallel. Steam and air pistons are of solid type, cored hollow to avoid unnecessary weight, and are provided with snap rings of special iron carefully fitted to place. They have no followers or bolts, thus avoiding liability of accident. Stuffing boxes are of ample depth. Piston rods are of steel, turned true and polished.

The air cylinders and cylinder heads are thoroughly water jacketed. Provision is made for a circulation of cold water the entire length of the cylinder, the water passing also through the heads, its cooling effect being especially concentrated around the discharge valves, which naturally sustain all of the heat due to compression and friction that has not been eliminated by the water jacket during the actual process of compression.

A novel feature, the value of which as a safeguard cannot be over-estimated, is an outside water connection for conducting

"WEAR WELL" LEATHER PACKING.

the circulation of water between air cylinder and cylinder head, excluding the possibility of serious accident through water entering the interior of the cylinder should the gasket between cylinder and head become ineffective.

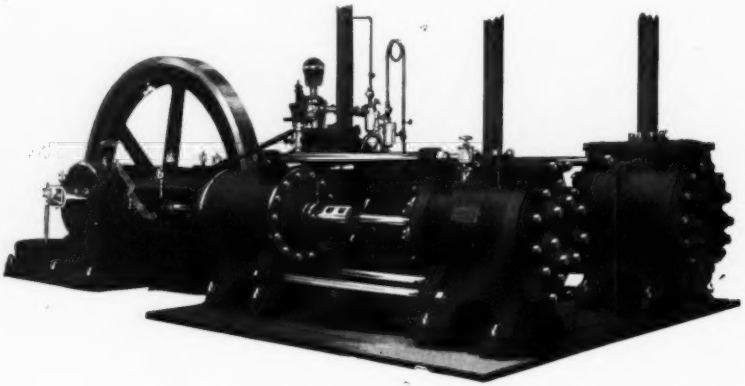
The bearings are exceptionally large and

well proportioned. The main bearings are provided with removable shell boxes and only the best phosphor bronze and genuine babbitt metal are used. All bearings are adjustable for wear, with ample provision for oiling. Steam valves are balanced slide valves, adjusted to realize the highest attainable economy in the consumption of steam and are provided with Meyer independent adjustable cut-off. All valves have provision for readjustment when required by wear.

The air inlet and discharge valves are of the poppet type, placed in the cylinder heads from the outside, and immediately accessible for adjustment or repair without removing the cylinder heads. The mechanism which may be examined, reground and adjusted separate from the compressor.

The valve seats are of bronze and the springs of steel, light enough to minimize resistance in opening, yet strong enough to promptly seat the valve in closing. The proportion of valve area to cylinder area is exceptionally liberal, enabling the cylinder to fill freely at each stroke, without volumetric loss or impaired efficiency due to the wire-drawing effect of insufficient valve area.

The cylinder flanges are recessed to effectually prevent the valves from falling into the cylinders, avoiding the necessity of a guard plate and the consequent clearance loss resulting from its use. The cranks are



CHICAGO COMPOUND AIR COMPRESSOR.

valve, valve stem and head are forged in one piece, entirely avoiding the use of flange nuts, jam nuts, split pins or other contrivances intended to serve as a head for the stem, which need constant supervision, with continual liability to work loose. A feature of more than ordinary importance embodied in this valve is the valve seat, which is a part entirely separate from the cylinder proper and which may be removed, replaced or renewed whenever occasion requires. In most forms of air compressors employing poppet valves, the valve seat forms an integral part of the cylinder head, affording no opportunity for renewal when it becomes worn; but in this machine the valve and seat form a complete piece of

of disc pattern, made from best quality charcoal iron. Shafts and crank pins are forced to their places, the former being keyed and the latter riveted, especial care being exerted to have the shaft and pins absolutely parallel. The crank pins are of special ground steel. Crank shafts are of unusual strength, made from best hammered machinery steel, accurately turned and finished.

Connecting rods are made from best forged steel, carefully finished. Boxes are adjustable for wear, and accord with the most approved practice, in all classes of compressors. The guides are bored and crossheads are provided with babbitted shoes at the top and bottom, with wedge adjustment for taking up wear.

A combined speed and pressure regulating governor, having a connection to the air receiver, is provided, and regulates the steam supply to the compressor to suit the air consumption, maintaining a constant air pressure, even though the demand be intermittent. Working in combination with this governor is a speed governor for regulating the speed of the engine.

The inter-cooler furnished with this type of compressor consists of a set of tubes encircled by a steel shell, into the heads of which the tubes are fitted, suitable provision being made for expansion and contraction. A constant circulation of cold water is maintained through the tubes, and the compressed air from the initial compressing cylinder enters the inter-cooler on one side and, after thorough distribution and contact with the tubes, discharges from the other side, passing to the next compressing stage. Adequate provision is made for readily cleaning the interior of the inter-cooler, and the tubes, being of composition metal, do not rust or become foul. This arrangement is superior to that in many other forms of compound compressors, where the advantages to be derived from two-stage compression are not realized because of inadequate cooling surface in the inter-cooler, or because the air comes into contact with the cooling surfaces but once in passing through the inter-cooler.

Complete provision is made for automatic oiling, sight-feed lubricators of ample capacity being furnished for steam and air cylinders, centrifugal oilers for crank-pin bearings, and oil cups of approved pattern for all wearing parts.

Steam and air cylinders have indicator connections, and indicator diagrams are taken under the exact working conditions.

This type of compressor is built in three sizes ranging in capacity from 500 to 2,000 cubic feet of free air per minute, and is also built with simple steam cylinders, for plants where the available steam pressure does not warrant compounding. Single and duplex compressors in a variety of sizes are also manufactured.

Compressors of this type are in operation at many plants, and any further information will be furnished by the Chicago Pneumatic Tool Co., Fisher Building, Chicago, and 95 Liberty St New York.

Heavy Upright Drilling Machines.

THE upright drill here shown is a thoroughly serviceable high-grade machine and is made with 6 or 7 spindles having either 14 or 18 inches swing. The table is extra heavy and is thoroughly braced, and it has a great length of travel, ranging from 0 to 32 inches between the spindles and the table. The countershaft is attached to the back of the columns and is supported at both ends with floor hangers. The driving pulleys are 10 inches by 3 inches, and, like all the other pulleys on the machine, are finished on the inside to prevent shaking when running at high speed.

The driving cones, being what are commonly called "two-piece cones," are the best

BARR UPRIGHT DRILLING MACHINE.

constructed pulley known to the trade. The spindle pulleys run on stationary sleeves and do not wear the spindle out of line. All the small posts are connected at the top with a solid yoke. The faces of the posts and column are surfaced to the plate and frosted. All the sliding surfaces are scraped and fitted. Every detail is of standard machine-tool finish and accuracy.

These 6 and 7-spindle upright drills weigh 1,500 pounds and 1,575 pounds, respectively, and are especially intended for manufacturers having need of a machine that is heavier in the column and the table than the usual design. Any further information will be cheerfully given by the manufacturer, Mr. H. G. Barr, of Worcester, Mass.

Pneumatic Rotary Drill.

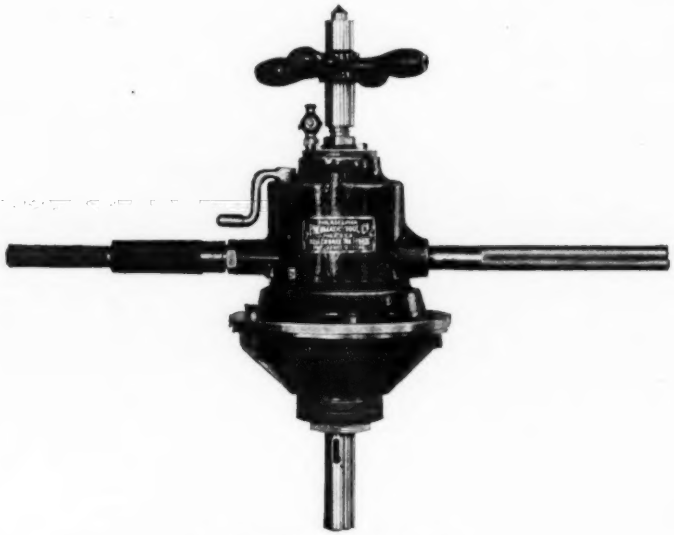
THE combination of a simple and practical design with the best workmanship obtainable, is necessary to the success of a pneumatic machine of any kind. Probably no other class of machinery is called upon for such exacting service, taking everything into account.

Remembering all this, the Philadelphia Pneumatic Tool Co. have placed their works where they can draw upon one of the largest communities of good machinists in the world, and they have put the highest skill into their shops. They have provided themselves with simple and practical designs, and they make certain that every machine sent out is all that the best material and workmanship and rigid inspection can secure for it.

The Keller rotary drill which this company manufactures has long been a favorite in bridge shops, boiler shops and shipyards, because it will do the heaviest work and stand the hard usage incident to such service.

There is nothing delicate or complicated about these rotary drills. While built for the hardest service they can be put to, they are finished with the high grade of machine work that is put on all the Philadelphia Company's tools. They have improved piston blades fitted with packing strips that require no attention to keep them tight. These are so made that as the machine wears, the bore of the cylinder acquires a glassy polish, similar to that found in steam cylinders. This precludes the possibility of future destructive wear.

The Keller rotary drills are made reversible by a simple turn of a lever. This makes them useful for tapping, flue-rolling and similar work. They are the most rugged pneumatic drills made, and years of service have demonstrated their great durability beyond question.



KELLER PNEUMATIC ROTARY DRILL.

The No. 11 rotary drill which is herewith illustrated is more in demand than any other size the Philadelphia Pneumatic Tool Co. makes. It is designed for general and heavy work in boiler shops, machine shops, shipyards, bridge shops, locomotive shops and railway repair shops. It is adapted to drilling, reaming, tapping, flue-rolling and staybolt screwing.

This drill weighs 45 pounds and it runs at 180 revolutions per minute, using 35 cubic feet of air at 80 pounds pressure. When

doing rapid work in steel its capacity is 1¾ inches for drilling, 1¼ inches for reaming and 1¼ inches for tapping.

There are three other sizes of these rotary drills. It is a mistake to suppose that they use more air than drills of the piston type. Repeated tests have proven that for the amount of metal removed, or work done, the air consumption is practically the same for both types, while the greater simplicity and consequent durability, of the rotary drills make them much more desirable.

The Philadelphia Pneumatic Tool Co., of Philadelphia, will be glad to furnish any further information desired concerning these tools.

Mechanical Oil Cup.

REALIZING the demand for a positive mechanically-operated lubricator, the Lunkenheimer Company, after much study and experimenting has brought out a first-class oil pump. This mechanical method of lubrication is more reliable than that obtained by lubricators hydrostatically operated, and when the apparatus is properly constructed, the oiling is absolutely positive, and all of the oil fed to the pump is bound to be forced to the steam chest or cylinder of the engine.

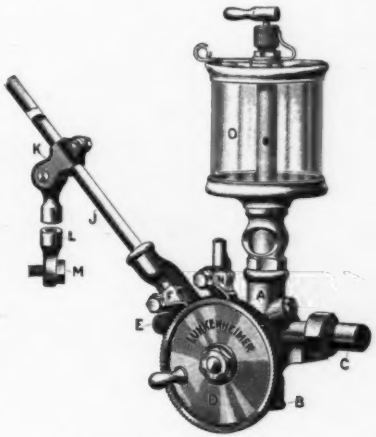
From the illustration it will be seen that the driving mechanism is of the ratchet type and is operated by the clutches *F* and *N* that work co-operatively by the motion of the rod *J*, which can be attached to the eccentric rod, or other moving parts of the engine, by the couplings *K* and *M*. The motion thus obtained is transmitted to the piston *E* by the crank-pin mechanism *H* and *G*.

The ratchet wheel *D* is provided with a handle whereby it can be rotated by hand in case it is desirable to force a quantity of oil at any time, as, for example, when starting the engine.

By moving the part *K* up or down the rod, the stroke of the pump can be lengthened or shortened, as desired, thus regulating the amount of oil fed by the pump, independent of the feed from the oil cup. The joints of the cup are tight, the sight-feed glass being packed so as to prevent the access of air that would have a tendency to cause the cup to feed after the engine had ceased running. This construction and the use of check valves in the pump prevent the oil supply from flooding.

The outlet *C* is piped to the steam pipe or chest of the engine, and the spring check valve *X* should be placed as near the end of the pipe as possible, preferably into the steam pipe.

The bottom of the pump body *B* is tapped with a ½-inch pipe thread to receive a stand so that it can be placed wherever desired. The pump is substantially constructed, the workmanship being of the best quality, and, as the parts are made to jigs and templets, they can all be easily renewed, being pertectly interchangeable.



LUNKENHEIMER OIL PUMP.

The ratchet wheel *D* and pawls *F* and *N* are made of tool steel, tempered and hardened. All other metal parts about the pump are made of the very best hard bronze composition.

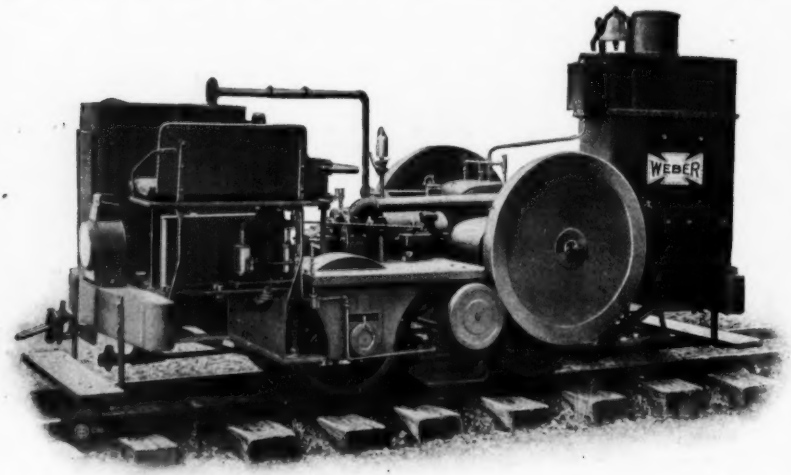
The Lunkenheimer mechanical oil pump has no equal as regards simplicity and positiveness of operation. They are carefully tested before shipment and satisfaction is guaranteed. The pump is listed with or without the oil cup. The cup usually supplied with the pump is the Lunkenheimer No. 5 "Sentinel" snap-lever sight-feed cup, and unless otherwise specified, the pump will be sent complete with the oil cup.

Any further information desired will be gladly furnished by the Lunkenheimer Company of Cincinnati.

Gasoline Locomotives.

THE cut on this page is a fair illustration of the Weber mine and industrial locomotive. It is supplied with a scrubber for neutralizing the effects of the products of combustion for tunnel work, or with a cab for the surface work. The frame is of steel, and by its peculiar construction great strength and rigidity is obtained to withstand hard usage. All holes are drilled and reamed, and turned drift bolts hold the parts solidly.

The engine is of the double-opposed cylinder type, and handles the load with ease and the least possible vibration. Both hot-tube and electric ignition are used. The engine transmits the power to the drivers by steel-cut gearing and the different motions —forward, backward and stops—are controlled by steel clutches that are operated by levers. The axle boxes are provided with vertical spaces for spring cushions to avoid jar. The drive wheels have steel tires (shrunk on) and are pressed on the axle and keyed. The system of supplying gasoline to the engine is simple, positive and requires scarcely any attention. The locomotive is supplied with a powerful brake, and when a very quick stop is necessary both the brake and reverse clutch can be applied. The scrubber is both simple and effectual, and needs only two or three minutes attendance a few times a day. It is durable and not likely to get out of order. It diminishes the objectionable effects of the products of combustion to a minimum. From the engineer's seat all levers and valves for controlling the locomotive are within easy reach, and he is able, by one of the improvements, to cut out either cylinder from work (as when running with light loads or switching and coupling cars), thus reducing the consumption of gasoline. As the locomotive is constructed, the engineer is able to look ahead so that he may see obstructions on the track.



WEBER GASOLINE LOCOMOTIVE.

The 4-ton locomotive, illustrated in the cut, is now in operation in a tunnel on the property of The Batopilas Mining Co., at Batopilas, Mexico. As this tunnel is almost 2 miles long the question of vitiating the air, by the exhaust gases from the engine, was a serious one. This was overcome by washing these gases in the scrubber shown on the right hand side of the engine.

The Weber Gas and Gasoline Engine Co., of Kansas City, will be pleased to furnish any more information concerning these interesting gasoline locomotives that may be desired.

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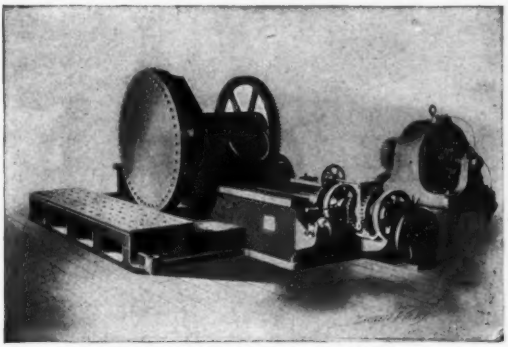

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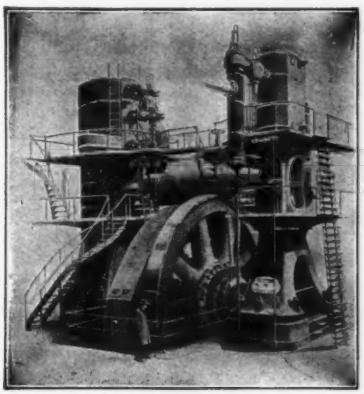

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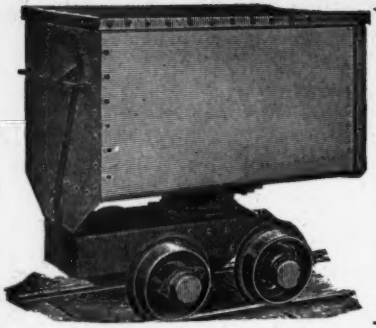

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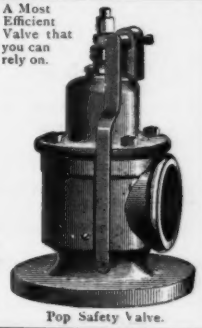

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AUTHORS AND PAPERS FOR MARCH, 1903.

HARRINGTON EMERSON *(American Overland Transport to the Orient)*—Born in Trenton, New Jersey, 1853. Educated in Europe, receiving the degree of M. A. at the Royal Polytechnic at Munich, Bavaria; professor at the State University of Nebraska, 1875; engaged in engineering work on the Burlington & Missouri R. R. in 1886, and has since been engaged in making inspections and preparing reports on important engineering and mining work in the United States, Mexico and Alaska; lately made a critical inspection of transportation facilities in connection with communication with the Klondike gold fields, and last year made an extended examination of the Alaskan coal measures. He has just returned from a second visit to the coal measures, which was extended to Nome and the interior so far as accessible so late in the year.

A. W. ROBINSON *(Modern Excavating and Dredging Machinery)*—For some years chief engineer of the Bucyrus Company, and now in consulting practice in Montreal. In these associations Mr. Robinson has designed and carried out some of the most important and successful work in the way of steam-shovel and dredge building and operation which has been done on the American continent. He has just returned from a trip to Europe in the course of which he renewed his acquaintance with what is being done in the same lines there. Mr. Robinson is a life member of the American Society of Mechanical Engineers and was one of the Managers 1896-1898. He is a member of the American Society of Civil Engineers and of the Canadian Society of Civil Engineers. His paper on the deepening of the St. Lawrence, recently read before the latter society, attracted wide attention.

ALBERT WILLIAMS, JR. *(The Management of Metalliferous Mines)*—Born in San Francisco in 1852; graduated from Phillips Academy, Andover, 1868; from Princeton, 1872, of which institution he is a Fellow in Experimental Science; took a special course at the Columbia College School of Mines, 1872-73; has had wide practice as a mining and metallurgical expert in various districts of the United States and Mexico; formerly chief of the Division of Mining Statistics and Technology of the United States Geological Survey, organizing that service and publishing the reports from 1882 to 1885; as director organized the Michigan Mining School, 1886-87; expert, Tenth and Eleventh United States Censuses; now a consulting engineer.

WILLIAM MAGRUTOR *(Cost-Finding Methods for Moderate-Sized Shops)*—The gentlemen who writes under the pen name of William Magrutor has devoted ten years to the study of machine-shop practice, during that time having been connected with some of the best shops of the United States. He is a member of the American Society of Mechanical Engineers and a practical shop manager as well as a technical graduate.

ROBERT BUCHANAN *(Foundry Management in the New Century)*—Born Paisley and educated at the Burgh Academy, Dumbarton; served an apprenticeship in the Dumbarton foundry of John Ure & Coy; thereafter had control of the Star foundry, and in connection with the well-known firm of Messrs. Denny carried out many tests and experiments with cast iron; held also appointments as manager in Glasgow and Dalkeith; at the present time he is foundry manager for W. & T. Avery, Ltd., weighing-machine manufacturers, Soho foundry, Birmingham. Long a student of metallurgy, and adding scientific

knowledge to an extensive practical experience, Mr. Buchanan brings to bear a balanced judgment by which the aids of science are profitably employed in the service of commerce as exmplified in a foundry. He is a member of the Staffordshire Iron and Steel Institute, and author of several contributions to foundry literature. The article in this issue is the fourth of a series dealing comprehensively with the subject of foundry management.

ELMER S. FARWELL *(The Betterment of Steam-Boiler Economy)*—Born at Morrison, Ill., 1863; was graduated at Baker University, at Rensselaer Polytechnic Institute, C. E., and at Columbian University, M. S.; was for some time mechanical engineer with the Illinois Steel Co., at South Chicago; entered the Patent Office in 1894 and, on account of his former experience, was soon assigned to the Division of Steam Engineering. He is a member of the Society for the Promotion of Engineering Education, and for some time taught steam engineering in Columbian University, Washington, D. C. At present he is steam engineer of the International Paper Company.

CHARLES M. JOHNSON *(The British Naval Engineer Under the New Scheme)*—Born 1838; studied engineering under the late John Chester Craven, locomotive engineer L. B. & S. C. Railway, and later entered the works of John Scott Russell & Co., then engaged in finishing the Great Eastern; in 1859 entered Her Majesty's Navy as assistant engineer, his first sea-going ship being H. M. S. Forte, bearing the flag of Rear Admiral Sir Harry Keppel on the Cape and West Coast Stations, and afterwards on the South American station, 1860-1864. His subsequent employment was:—1865-1870, Arethusa and Wizard, Mediterranean station, with a few months as engineer-in-charge Gibraltar dockyard; 1873-1876, Thistle, China and Straits of Malacca station, specially promoted chief engineer for services in Perak expedition; 1876-1878, Cyclops, home and Channel service; 1879-1882, Swiftsure, preparing for foreign service, and 1882-1885, chief engineer H. M. S. Swiftsure, flag-ship of Admiral Sir Algernon Lyons, K. C. B., Pacific station; 1887-1890, superintending engineer Bermuda dockyard, with rank of inspector of machinery; 1891-1892, chief inspector of machinery to the Mediterranean fleet and in the island of Malta; 1892-1896, chief inspector of machinery of the fleet and dockyard reserves, and to commander-in-chief at Mount Wise, Devonport; 1896, retired. Mr. Johnson's articles on the former unsatisfactory status of the naval engineer were important contributions in the reform campaign which has just had so triumphant an ending.

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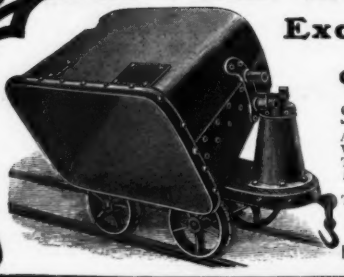

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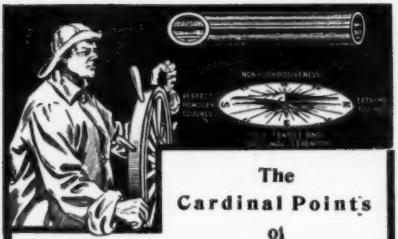

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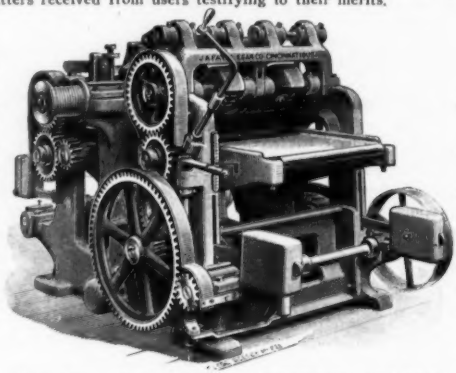

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L. E. Darling, 79 Sabin St., Providence, R. I.
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Adam Weber Sons, Park Row Bldg., New York.

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Potter & Johnston, Pawtucket, R. I.
Standard Tool Co., Cleveland, Ohio.

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Western Electric Co., Chicago, Ill.

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American Blower Co., Detroit, Mich.
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Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Vulcan Iron Works, Toledo, Ohio.

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American Watchman's Time Detector Co., 234 Broadway, N. Y. City.
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Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Coal-Mining Machinery.

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Buffalo Forge Co., Buffalo, N. Y.
General Electric Co., New York.
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Jeffrey Manufacturing Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Triumph Electric Co., Cincinnati, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Allis-Chalmers Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.

Concentrators.

Joshua Hendy Machine Works, San Francisco, Cal.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.

Condensers.

Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.

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Eynon-Evans Mfg. Co., 15th & Clearfield Sts., Philadelphia, Pa.
Guild & Garrison, Brooklyn, N. Y.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Southwark Foundry & Machine Co., Phila., Pa.
Struthers-Wells Co., Warren, Pa.
Union Steam Pump Co., Battle Creek, Mich.
Henry R. Worthington, 114 Liberty St., New York.

Construction Timbers (Yellow Pine).

American Lumber & Mfg. Co., Pittsburg, Pa.

Continuous Rolling Mills.

Morgan Construction Co., Worcester, Mass.

Conveying Machinery.

Aultman Company, Canton, Ohio.
Browning Engineering Co., Cleveland, O.
H. W. Caldwell & Sons Co., Chicago, Ill.
Frick Company, Waynesboro, Pa.
The Hayward Co., 97 Cedar St., New York.
Heyl & Patterson, Pittsburg, Pa.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
The Trenton Iron Co., Trenton, N. J.

Cooling Towers.

Alberger Condenser Co., 95 Liberty St., New York.
Henry R. Worthington, New York City.

Copper.

Orford Copper Co., 37 Wall St., New York.

Core Ovens.

Millett Core Oven Co., Brightwood, Mass.

Cost Systems.

Baker-Vawter Co., Chicago, Ill.
Gunn & Richards, 25 Pine St., New York.
Hugo Diemer, Lawrence, Kansas.
The Shaw-Walker Co., Muskegon, Mich.

Cranes.

American Hoist & Derrick Co., St. Paul, Minn.
Browning Engineering Co., Cleveland, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Garry Iron & Steel Co., Cleveland, Ohio.
Hayward Co., 97 Cedar St., New York.
Industrial Works, Bay City, Mich.
Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
R. D. Wood & Co., Philadelphia, Pa.

Crucibles.

F. W. Braun & Co., Los Angeles, Cal.
R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Crushers—Ore, Phosphate, Rock.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
F. W. Braun & Co., Los Angeles, Cal.
Diamond Drill & Machine Co., Birdsboro, Pa.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Crusher Rings and Shells (Steel).

Latrobe Steel Co., Philadelphia, Pa.

Cupel Machines.

F. W. Braun & Co., Los Angeles, Cal.

Cupolas.

Northern Engineering Works, Detroit, Mich.
Riter-Conley Mfg. Co., Pittsburg, Pa.
F. B. Stevens, Detroit, Mich.

Cutters, Milling.

Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.

Diamond Drills.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 128 Broadway, New York.

Dies.

Geometric Drill Co., New Haven, Conn.

Die Heads.

Geometric Drill Co., New Haven, Conn.

Die Making Machinery.

Cochrane-Bly Machine Works, Rochester, N. Y.

Digesters.

Atlantic Works, East Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Enterprise Boiler Co., Erie, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Draw Benches, Wire.

Trenton Iron Co., Trenton, N. J.

Draught Gauges.

Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Draughtsmen's Instruments and Materials.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill.
Keuffel & Esser Co., New York.

Dredges—SEE EXCAVATORS.

Drilling Machines.

American Tool Works Co., Cincinnati, Ohio.
Baush Machine Tool Co., Springfield, Mass.
W. F. & John Barnes Co., Rockford, Ill.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Pneumatic Tool Co., Chicago, Ill.
Thos. H. Dallett & Co., Philadelphia, Pa.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Niles Tool Works Co., Hamilton, Ohio.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
O & C Co., Chicago, Ill.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drills—Rock and Coal.

American Diamond Rock Drill Co., 95 Liberty St., New York.
H. D. Crippen, 52 B'way, N. Y.
Clayton Air Compress. Wks., 120 Liberty St., N.Y.
Davis Calyx Drill Co., 128 Broadway, New York.

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Hall Steam Pump Co., Pittsburg, Pa.
Joshua Hendy Machine Works, San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
J. Geo. Leyner, 1033 17th St., Denver, Colo.
Rand Drill Co., 128 Broadway, New York.
Star Drilling Machine Co., Akron, Ohio.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
New York Blower Co., Cleveland, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Dynamos.

American Engine Co., Bound Brook, N. J.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
C & C Electric Co., 143 Liberty St., New York.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Joshua Hendy Machine Works, San Francisco, Cal.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Ejectors.

Hancock Inspirator Co., 85 Liberty St., New York.
Hayden & Derby Mfg. Co., New York.
Watson & McDaniel Co., Philadelphia, Pa.

Electric Hoists.

Browning Engineering Co., Cleveland, O.
C & C Electric Co., New York, N. Y.
Joshua Hendy Machine Works, San Francisco, Cal.
C. W. Hunt Co., West New Brighton, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Northern Engineering Works, Detroit, Mich.
Shaw Electric Crane Co., Muskegon, Mich.

Electric Heating Apparatus.

Simplex Electric Heating Co., Cambridgeport, Mass.

Electrical Machinery and Supplies.

Akron Electrical Mfg. Co., Akron, Ohio.
American Engine Co., Bound Brook, N. J.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Bristol Co., Waterbury, Conn.
C & C Electric Co., 143 Liberty St., New York.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
Deane Steam Pump Co., Holyoke, Mass.
General Electric Co., New York.
Joshua Hendy Machine Works, San Francisco, Cal.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Wm. E. Quimby, Inc., 86 Liberty St., New York.
Snow Steam Pump Works, Buffalo, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Western Electric Company, Chicago, Ill.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.
Henry R. Worthington, 114 Liberty St., New York.

Electrical Wires.

American Steel & Wire Co., Chicago, Ill.

Elevators.

American Tool & Machine Co., Boston, Mass.
Aultman Co., Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.
Morse Elevator Works, Philadelphia, Pa.
R. Poole & Son Co., Baltimore, Md.
Triumph Electric Co., Cincinnati, Ohio.

Emery Wheels.

Carborundum Co., Niagara Falls, N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.

Engineers, Civil.

Robert W. Hunt & Co., 1121 The Rookery, Chicago, Ill.
Chas. C. Moore & Co., San Francisco, Cal.
Sydney F. Reynolds, Torrey, Pa.
A. W. Robinson, Montreal, Canada.
Samuel Storrow, Los Angeles, Cal.

Engineers, Electrical.

Clay Belsley, Peoria, Ill.
Crocker-Wheeler Co., Ampere, N. J.
Iron City Engineering Co., Pittsburg, Pa.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
W. K. Palmer, 823 Manhattan Bldg., Chicago, Ill.
Sydney F. Reynolds, Torrey, Pa.
Philip K. Stern, 130 Fulton St., New York.

Engineers, Mechanical.

Wm. S. Aldrich, Potsdam, N. Y.
Clay Belsley, Peoria, Ill.
William M. Brewer, Vancouver, B. C.
Geo. M. Brill, Marquette Bldg., Chicago, Ill.
Edward S. Cobb., Torrey, Pa.
Hugo Diemer, Lawrence, Kans.
Robt. McF. Doble, 314 Hayward Bldg., San Francisco, Cal.
Alfred G. Heggem, Massillon, Ohio.
Holt & Schober, 378 Bourse, Philadelphia, Pa.
S. Y. Huber & Co., Pittsburg, Pa.
Julian Kennedy, Pittsburg, Pa.
Walter Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Pittsburg, Pa.
Milton L. Oglesby, 429 Atlas Block, Salt Lake City, Utah.
W. K. Palmer, 401 N. Y. Life Bldg., Kansas City, Mo.
C. L. Redfield, 1563 Monadnock Block, Chicago, Ill.
Sydney F. Reynolds, Torrey, Pa.
A. W. Robinson, Montreal, Canada.
H. B. Roelker, 41 Maiden Lane, New York.
Chas. S. Sage, Wellsville, N. Y.
Philip K. Stern, 130 Fulton St., New York.
Wellman-Seaver-Morgan Engineering Co., Cleveland, Ohio.

Engineers, Mining.

William M. Brewer, Vancouver, B. C.
Chas. Catlett, Staunton, Va.
John S. Cummings, Tunnelton, W. Va.
L. B. Darling, Providence, R. I.
Chas. F. Howe, Gainesville, Ga.
Bernard MacDonald, Spokane, Wash.
Milton L. Oglesby, 429 Atlas Block, Salt Lake City, Utah.
Sydney F. Reynolds, Torrey, Pa.
Samuel Storrow, Los Angeles, Cal.

Engines, Blowing.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
New York Blower Co., Cleveland, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
Southwark Foundry & Machine Co., Phila., Pa.
The Wm. Tod Company, Youngstown, O.

Engines—Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Loxier Motor Co., Plattsburg, N. Y.
Machinery & Electrical Co., Los Angeles, Cal.
Northern Engineering Works, Detroit, Mich.
Struthers-Wells Company, Warren, Pa.
Weber Gas & Gasoline Engine Co., Kansas City, Mo.

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Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Wolcott Windmill Co., Saginaw, Mich.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Lozier Motor Co., Plattsburg, N. Y.
Marine Iron Works, Chicago, Ill.

Engines, Stationary.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., 120 Liberty St., New York.
A. F. Bartlett & Co., Saginaw, Mich.
Bradley Mfg. Co., Allegheny, Pa.
Brown Corliss Engine Co., Milwaukee, Wis.
Buffalo Forge Co., Buffalo, N. Y.
Chandler & Taylor Co., Indianapolis, Ind.
Frick Company, Waynesboro, Pa.
Harrisburg Foundry & Machine Co., Harrisburg, Pa.
Chas. L. Heisler, M. E., Erie, Pa.
Henshaw, Bulkley & Co., San Francisco, Cal.
Hooven, Owens, Rentschler Co., Hamilton, Ohio.
S. W. Luitwieler Co., Los Angeles, Cal.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
J. S. Mundy, Newark, N. J.
Frank M. Pierce Engineering Co., 135 B'way, N. Y.
Providence Engineering Works, Providence, R. I.
Rider-Ericsson Engine Co., New York City.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Phila., Pa.
Star Drilling Machine Co., Akron, Ohio.
Struthers-Wells Company, Warren, Pa.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
The William Tod Co., Youngstown, Ohio.
Vulcan Iron Works, San Francisco, Cal.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robt. Wetherill & Co., Chester, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engravers.

C. P. Zacher & Co., Chicago, Ill.

Excavators.

Atlantic, Gulf & Pacific Co., Park Row Bldg., N. Y.
Bucyrus Co., So. Milwaukee, Wis.
The Hayward Co., 97 Cedar St., New York.
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Exhaust Heads.

Buffalo Forge Co., Buffalo, N. Y.
Direct Separator Co., Syracuse, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Fans, Ventilating.

Allis-Chalmers Co., Chicago, Ill.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Sprague Electric Co., 527 W. 34th St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Western Electric Company, Chicago, Ill.

Feed-Water Heaters and Purifiers.

Allis-Chalmers Co., Chicago, Ill.
Dodge Mfg. Co., Mishawaka, Ind.
Goubert Mfg. Co., 85 Liberty St., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Providence Engineering Works, Providence, R. I.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Stewart Heater Co., Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Warren Webster & Co., Camden, N. J.
Robt. Wetherill & Co., Chester, Pa.

Fertilizer Machinery.

Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.

Files and Rasps.

G. & H. Barnett Co., Philadelphia, Pa.

Filters.

Enterprise Boiler Co., Erie, Pa.
L. O. Koven & Bro., New York City.
New York Cont. Jewell Filt. Co., 15 Broad St., N. Y.
Ross Valve Co., Troy, N. Y.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Robt. Wetherill & Co., Chester, Pa.

Fire Brick.

Henry Maurer & Son, 420 East 23d St., New York.

Fireproof Building Materials.

Henry Maurer & Son, 420 East 23d St., New York.
National Fireproofing Co., Pittsburg, Pa.

Fire Pumps.

American Fire Engine Co., Seneca Falls, N. Y.

Flanges.

Latrobe Steel Co., 1200 Girard Bldg., Phila., Pa.

Flexible Shafts.

Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flooring, Factory.

American Lumber & Mfg. Co., Pittsburg, Pa.

Flue Scrapers.

Lagonda Mfg. Co., Springfield, Ohio.

Fly Wheels.

Allis-Chalmers Co., Chicago, Ill.
Dodge Mfg. Co. Mishawaka, Ind.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Robt. Wetherill & Co., Chester, Pa.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Forgings, Iron and Steel.

Chester B. Albree, Allegheny, Pa.
Keystone Drop Forge Works, Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
J. S. Mundy, Newark, N. J.
Pennsylvania Steel Co., Steelton, Pa.
Wyman & Gordon, Worcester, Mass.

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Foundry Equipment.

Blanchard Machine Co., Boston, Mass.
Buffalo Foundry Co., Buffalo, N. Y.
Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
C. W. Hunt Co., West New Brighton, N. Y.
Arthur Koppel, 68 Broad St., New York.
Millett Core Oven Co., Brightwood, Mass.
Northern Engineering Works, Detroit, Mich.
Pedrick & Ayer Co., Philadelphia, Pa.
Shaw Electric Crane Co., Muskegon, Mich.
F. B. Stevens, Detroit, Mich.

Friction Clutches.

American Tool & Machine Co., Boston, Mass.
H. W. Caldwell & Sons Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Fuel Economizers.

Green Fuel Economizer Co., Matteawan, N. Y.
Providence Engineering Works, Providence, R. I.
Steam Boiler Equipment Co., 30 W. Houston St., New York.

Fuel Gas Producer.

Loomis-Pettibone Co., 52 Broadway, New York.

Furnace Builders.

American Gas Furnace Co., 23 John St., New York.
Buffalo Forge Co., Buffalo, N. Y.
Continental Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Julian Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Wellman-Seaver-Morgan Eng'ng Co., Cleveland, O.

Furnaces, Assayers.

F. W. Braun & Co., Los Angeles, Cal.

Gages—Pressure, Steam, Water, etc.

Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
John Simmons Co., 110 Centre St., New York.
Star Brass Mfg. Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Galvanizing.

L. O. Koven & Bro., New York City.
John Simmons Co., 110 Centre St., New York.

Gas Exhausters.

American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Boston, Mass.

Gas Holders and Regulators.

Continent. Iron Wks., West & Calyer Sts., Brooklyn, N. Y.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Gaskets, Metallic.

Boston Belting Co., Boston, Mass.

Gas Machines and Generators.

American Gas Furnace Co., 23 John St., New York.
Duffs Patents Co., Pittsburg, Pa.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Morgan Construction Co., Worcester, Mass.
R. D. Wood & Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gear Cutting Machines.

Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Gould & Eberhardt, Newark, N. J.

Gearing.

Allis-Chalmers Co., Chicago, Ill.
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Boston Gear Works, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
H. W. Caldwell & Son Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Dodge Mfg. Co., Mishawaka, Ind.
Gould & Eberhardt, Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Morse Elevator Works, Philadelphia, Pa.
J. S. Mundy, Newark, N. J.
New Process Rawhide Co., Syracuse, N. Y.
R. D. Nuttall Co., Pittsburg, Pa.
R. Poole & Son Co., Baltimore, Md.
William Sellers & Co., Inc., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Stow Flexible Shaft Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.

Grain Elevator Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Graphite.

Jos. Dixon Crucible Co., Jersey City, N. J.

Grinding and Polishing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Diamond Machine Co., Providence, R. I.
Dodge Mfg. Co. Mishawaka, Ind.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Iroquois Machine Co., 350 Nassau St., New York.
Landis Tool Co., Waynesboro, Pa.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Stow Flexible Shaft Co., Philadelphia, Pa.
Washburn Shops, Worcester, Mass.

Hangers—SEE PULLEYS.

Heading and Upsetting Machines.

National Machinery Co., Tiffin, Ohio.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Hayden & Derby Mfg. Co., New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
New York Blower Co., Cleveland, Ohio.
John Simmons Co., 110 Centre St., New York.
Sprague Electric Co., 527 W. 34th St., New York.
H. B. Smith Co., 137 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Mfg. Co., Boston, Mass.

Hoisting Crabs.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Hoisting Engines and Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
A. F. Bartlett & Co., Saginaw, Mich.
Browning Engineering Co., Cleveland, Ohio.

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Chicago Pneumatic Tool Co., Chicago, Ill.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
The Hayward Co., 97 Cedar St., New York.
Joshua Hendy Machine Works, San Francisco, Cal.
Henshaw, Bulkley & Co., San Francisco, Cal.
C. W. Hunt Co., West New Brighton, New York.
Industrial Works, Bay City, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Machinery & Electrical Co., Los Angeles, Cal.
P. B. McCabe & Co., 602 No. Main St., Los Angeles, Cal.
John A. Mead Mfg. Co., 11 Broadway, New York.
J. S. Mundy, Newark, N. J.
Niles Tool Works Co., Hamilton, Ohio.
Northern Engineering Works, Detroit, Mich.
Providence Engineering Works, Providence, R. I.
Q & C Co., Chicago, Ill.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works, Wilkesbarre, Pa.
Webster, Camp & Lane Machine Co., Akron, O.
Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Hollow Chisel Mortisers.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Hose.

Boston Belting Co., Boston, Mass.
Eureka Fire Hose Co., New York City.

Hydraulic Machinery.

Christiana Machine Co., Christiana, Pa.
Joshua Hendy Machine Works, San Francisco, Cal.
S. V. Huber & Co., Pittsburg, Pa.
John H. McGowan Co., Cincinnati, Ohio.
S. Morgan Smith Co., York, Pa.
Pelton Water Wheel Co., San Francisco, Cal.
R. Poole & Son Co., Baltimore, Md.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Rams.

Pelton Water Wheel Co., San Francisco, Cal.

Hydraulic Tools.

Diamond Drill & Machine Co., Birdsboro, Pa.

Ice-Making and Refrigerating Machinery.

Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Frick Company, Waynesboro, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
H. B. Rocker, 41 Maiden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Vulcan Iron Works, San Francisco, Cal.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Henry R. Worthington, 114 Liberty St., New York.

Impulse Water Wheels.

Pelton Water Wheel Co., San Francisco, Cal.

Incandescent Lamps —SEE LAMPS, ELECTRIC.

Injectors.

Eynon-Evans Mfg. Co., 15th & Clearfield Sts., Philadelphia, Pa.
Hayden & Derby Mfg. Co., New York.
The Lunkenheimer Co., Cincinnati, Ohio.
John Simmons Co., 110 Centre St., New York.
Wm. Sellers & Co., Philadelphia, Pa.

Inspirators.

Hancock Inspirator Co., 85 Liberty St., New York.

Instruments, Surveying and Engineering.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Eugene Dietzgen Co., Chicago, Ill.
Keuffel & Esser Co., New York City.

Insulated Wire.

American Steel & Wire Co., Chicago, Ill.
General Electric Co., New York.
Hazard Mfg. Co., Wilkes-Barre, Pa.
John A. Roebling's Sons Co., Trenton, N. J.
Sprague Electric Co., 527 W. 34th St., New York.

Insulating Materials.

Sterling Varnish Co., Pittsburg, Pa.
Xylotite Mfg. Co., Cincinnati, Ohio.

Internal Gearing.

R. D. Nuttall Co., Pittsburg, Pa.

Jacks.

Duff Mfg. Co., Pittsburg, Pa.

Jacks, Hydraulic.

Watson-Stillman Co., New York City.

Jet Apparatus.

Hancock Inspirator Co., 85 Liberty St., New York.
Hayden & Derby Mfg. Co., New York.

Keyseaters.

Morton Mfg. Co., Muskegon Heights, Mich.

Kiers.

Atlantic Works, East Boston, Mass.

Laboratory Supplies.

F. W. Braun & Co., Los Angeles, Cal.

Lamps, Electric.

General Electric Co., New York.
General Incandescent Lamp Co., Cleveland, Ohio.
Regina Arc Lamp Works, Cologne, Germany.
Sterling Electrical Mfg. Co., Warren, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Western Electric Company, Chicago, Ill.

Lathe Pans.

New Britain Machine Co., New Britain, Conn.

Lathes.

American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
Cincinnati Milling Machine Co., Cincinnati, O.
Diamond Machine Co., Providence, R. I.
Fay & Scott, Dexter, Me.
A. Garrison Foundry Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Launches.

Lozier Motor Co., Plattsburg, N. Y.

Leather, Hydraulic, Valve and Pump.

Chas. A. Schieren & Co., 45-51 Ferry St., New York.

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Leather Packing.
Detroit Leather Specialty Co., Detroit, Mich.

Light Draft Steam Vessels.
Marine Iron Works, Chicago, Ill.

Light Railways.
Dodge Mfg. Co., Mishawaka, Ind.
C. W. Hunt Co., West New Brighton, New York.
Arthur Koppel, 68 Broad St., New York.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
John A. Mead Mfg. Co., 11 Broadway, New York.

Lithographing.
The Forbes Lithograph Mfg. Co., Boston, Mass.

Lockers.
Merritt & Co., Philadelphia, Pa.
Narragansett Machinery Co., Providence, R. I.

Locomotive Cranes.
Browning Engineering Co., Cleveland, Ohio.
Industrial Works, Bay City, Mich.

Locomotives, Compressed Air.
Baldwin Locomotive Works, Phila, Pa.
H. K. Porter Co., Pittsburg, Pa.

Locomotives, Electric.
Baldwin Locomotive Works, Philadelphia, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Arthur Koppel, 68 Broad St., New York.
H. K. Porter Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Locomotives, Steam.
American Locomotive Co., 25 Broad St., New York.
Baldwin Locomotive Works, Philadelphia, Pa.
Lima Locomotive & Machine Co., Lima, Ohio.
H. K. Porter Co., Pittsburg, Pa.
Rogers Locomotive Works, Paterson, N. J.
Vulcan Iron Works, Wilkesbarre, Pa.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.

Machinery Exhibit.
Bourse, Philadelphia, Pa.

Machine Tools and Supplies.
American Tool & Machine Co., Boston, Mass.
American Tool Works Co., Cincinnati, O.
W. F. & John Barnes Co., Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crane Co., Chicago, Ill.
The Curtis & Curtis Co., Bridgeport, Conn.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Hilles & Jones Co., Wilmington, Del.
Jones & Lamson Machine Co., Springfield, Vt.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Niles Tool Works Co., Hamilton, O.
Pearson Machine Co., Chicago, Ill.
Pond Machine Tool Co., Plainfield, N. J.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Company, Worcester, Mass.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walworth Manufacturing Co., Boston, Mass
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Whitcomb Mfg. Co., Worcester, Mass.

Machine Keys.
Morton Mfg. Co., Muskegon Heights, Mich.

Machinists' Small Tools.
American Tool Works Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Geometric Drill Co., New Haven, Conn.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.

Mechanical Draft.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
New York Blower Co., Cleveland, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Metal Saw Machinery.
The Q & C Co., Chicago, Ill.

Meters, Electric.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Elec. Inst. Co., Waverly Pk., Essex Co., N.J.

Milling Machines.
Adams Company, Dubuque, Iowa.
American Tool & Machine Co., Boston, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Milling Tools.
Geometric Drill Co., New Haven, Conn.

Mill Supplies.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.

Mine Cars.
Allis-Chalmers Co., Chicago.
Joshua Hendy Machine Works, San Francisco, Cal.
C. W. Hunt Co., West New Brighton, N. Y.
Jeffrey Manufacturing Co., Columbus, Ohio.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Arthur Koppel, 68 Broad St., New York.
Lima Locomotive and Machine Co., Lima, O.
Watt Mining Car Wheel Co., Barnesville, Ohio.

Mining Machinery.
Allis-Chalmers Co., Chicago, Ill.
American Diamond Rock Drill Co., 95 Liberty St., New York.
A. F. Bartlett & Co., Saginaw, Mich.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Davis Calyx Drill Co., 128 Broadway, New York.
Deane Steam Pump Co., Holyoke, Mass.
Diamond Drill & Machine Co., Birdsboro, Pa.
Eastwood Wire Mfg. Co., Belleville, N. J.
General Electric Co., New York.
Joshua Hendy Machine Works, San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
J. Geo. Leyner, 1033 17th St., Denver, Colo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.

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The Machinery & Electrical Co., Los Angeles, Cal.
Marion Steam Shovel Co., Marion, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
J. S. Mundy, Newark, N. J.
Norwalk Iron Works, South Norwalk, Conn.
Phillips Mine & Mill Supply Co., Pittsburg, Pa.
Providence Engineering Works, Providence, R. I.
Pulsometer Steam Pump Co., New York City.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Malden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Trenton Iron Works Co., Trenton, N. J.
Union Steam Pump Co., Battle Creek, Mich.
Vulcan Iron Works, San Francisco, Cal.
Vulcan Iron Works Co., Toledo, Ohio.
Watt Mining Car Wheel Co., Barnesville, Ohio.
Webster, Camp & Lane Machine Co., Akron, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Henry R. Worthington, 114 Liberty St., New York.

Mining Screens—SEE SCREENS.

Motors, Electric.

Akron Electrical Mfg. Co., Akron, Ohio.
American Engine Co., Bound Brook, N. J.
C & C Electric Co., 145 Liberty St., New York.
Christensen Engineering Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Guarantee Electric Co., Chicago, Ill.
Joshua Hendy Machine Works, San Francisco, Cal.
Jantz & Leist Electric Co., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Sprague Electric Co., 527 W. 34th St., New York.
Stow Mfg. Co., Binghamton, N. Y.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Western Electric Company, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Moulding Machines.

Tabor Mfg. Co., 1742 Hamilton St., Philadelphia, Pa.

Multiple Spindle Drills.

Baush Machine Tool Co., Springfield, Mass.

Naphtha Gas Machines.

American Gas Furnace Co., 23 John St., New York.

Nickel.

Benedict & Burnham Mfg. Co., Waterbury, Conn.
Orford Copper Co., 37 Wall St., New York.

Nozzles.

R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Nut Tappers.

National Machinery Co., Tiffin, Ohio.

Oak Timbers.

American Lumber & Mfg. Co., Pittsburg, Pa.

Oil Cups.

New Britain Machine Co., New Britain, Conn.

Open Hearth Furnaces.

G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Wellman-Seaver-Morgan Eng'g Co., Cleveland, O.

Ore-Roasting Machinery.

Allis-Chalmers Co., Chicago, Ill.

Packing.

Boston Belting Co., Boston, Mass.
Detroit Leather Specialty Co., Detroit, Mich.
Jenkins Brothers, 71 John St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.

Packing, Metallic.

The Hileman-James Co., Pittsburg, Pa.

Paints and Varnishes.

Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Sterling Varnish Co., Pittsburg, Pa.

Paper-Mill Machinery.

Aultman Company, Canton, Ohio.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Snow Steam Pump Works, Buffalo, N. Y.
Henry R. Worthington, 114 Liberty St., New York.

Patent Attorneys.

C. A. Dieterich, 229 Broadway, New York.
Evans, Wilkins & Co,. Evans Building, Washington, D. C.
Philip K. Stern, 130 Fulton St., New York.

Pattern-Makers' Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Fay & Scott, Dexter, Me.
Pratt & Whitney Co., Hartford, Conn.

Pattern Makers.

Diamond Drill & Machine Co., Birdsboro, Pa.
Eynon-Evans Mfg. Co., 15th & Clearfield Sts., Philadelphia, Pa.

Perforated Metal.

Robt. Aitchinson Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
H. W. Caldwell & Sons Co., Chicago, Ill.
Hendrick Mfg. Co., Carbondale, Pa.

Phosphor Bronze.

Eastwood Wire Mfg. Co., Belleville, N. J.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
R. Poole & Sons Co., Baltimore, Md.
Paul S. Reeves & Son., Philadelphia, Pa.

Pinions.

A. Garrison Foundry Co., Pittsburg, Pa.

Pipe.

American Spiral Pipe Works, Chicago, Ill.
Enterprise Boiler Co., Erie, Pa.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Nason Mfg. Co., 71 Fulton St., New York.
The Michigan Pipe Co., Bay City, Mich.
Pelton Water Wheel Co., San Francisco, Cal.
Weigele Riveted Steel Pipe Works, Denver, Colo.

Pipe, Cast-Iron.

L. O. Koven & Bro., New York City.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Pipe Coverings.

F. J. Gast, 23 Dey St., New York.
Michigan Pipe Co., Bay City, Mich.

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Pipe-Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Cox & Sons Company, Bridgeton, N. J.
Merrell Mfg. Co., Toledo, Ohio.
Niles Tool Works Co., Hamilton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.

Kelly & Jones Co., Greensburg, Pa.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Nason Mfg. Co., 71 Fulton St., New York.
Pelton Water Wheel Co., San Francisco, Cal.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.

Pipe Vises.

John Simmons Co., 110 Centre St., New York.

Planers.

American Tool Works Co., Cincinnati, Ohio.
E. C. Bartlett, Boston, Mass.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Hilles & Jones Co., Wilmington, Del.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Whitcomb Mfg. Co., Worcester, Mass.
W. A. Wilson, Rochester, N. Y.

Planing Mill Machinery.

Buffalo Forge Co., Buffalo, N. Y.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Platinum Ware.

F. W. Braun & Co., Los Angeles, Cal.
J. C. Entriken, Malvern, Pa.

Pneumatic Tools.

Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compress. Wks., 26 Cortlandt St., N.Y.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
The Q & C Co., Chicago, Ill.
Standard Railway Equipment Co., St. Louis, Mo.

Pop Safety Valves.

Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Star Brass Mfg. Co., Boston, Mass.

Power Hammers.

H. G. Barr, Worcester, Mass.
Beaudry & Co., 8 Oliver St., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Power-Transmission Machinery.

Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Dodge Mfg. Co., Mishawaka, Ind.
General Electric Co., New York.
Hayward Co., 97 Cedar St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Niles Tool Works Co., New York, N. Y.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
S. Morgan Smith Co., York, Pa.
Sprague Electric Co., 527 W. 34th St., New York.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Pressed Steel Barrels.

Pressed Steel Tank Co., Milwaukee, Wis.

Presses and Dies.

E. E. Bartlett, 370 Atlantic Ave., Boston, Mass.
The Curtis & Curtis Co., Bridgeport, Conn.
Niagara Machine & Tool Works, Buffalo, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Pressure Regulators—Steam, Water and Air.

Julian D'Este Company, 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.

Printing.

The Forbes Lithograph Mfg. Co., Boston, Mass.

Promoters.

Railways and Light Co. of America, Baltimore, Md.

Propeller Wheels.

Marine Iron Works, Chicago, Ill.

Prospecting Drills.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Davis Calyx Drill Co., 128 Broadway, New York.
Star Drilling Machine Co., Akron, Ohio.

Production Engineers.

Gunn & Richards, 25 Pine St., New York.

Pulleys, Shafting and Hangers.

Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Aultman Company, Canton, Ohio.
H. W. Caldwell & Sons Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Niles Tool Works Co., New York, N. Y.
R. Poole & Son Co., Baltimore, Md.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Xylotite Mfg. Co., Cincinnati, Ohio.

Pulverizers.

F. W. Braun & Co., Los Angeles, Cal.

Pumps and Pumping Machinery.

Alberger Condenser Co., 95 Liberty St., New York.
Allis-Chalmers Co., Chicago, Ill.
American Fire Engine Co., Seneca Falls, N. Y.
American Well Works, Aurora, Ill.
Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Geo. F. Blake Mfg. Co., 91 Liberty St., N. Y.
Bucyrus Co., So. Milwaukee, Wis.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air Compress. Wks., 26 Cortlandt St., N. Y.

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The Deane Steam Pump Co., of Holyoke, 114 Liberty St., New York.
Epping-Carpenter Co., Pittsburg, Pa.
Flint & Walling Mfg. Co., Kendallville, Ind
Guild & Garrison, Brooklyn, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Joshua Hendy Machine Works, San Francisco, Cal.
Chas. L. Heisler, Erie, Pa.
Henshaw, Bulkley & Co., San Francisco, Cal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y
Kingsford Fdy. & Mch. Works, Oswego, N. Y.
Knowles Steam Pump Wks., 91 Liberty St., N. Y
The Laidlaw-Dunn-Gordon Co., 120 Liberty St., N.Y
S. W. Luitwieler Co., Los Angeles, Cal.
Machinery & Electrical Co., Los Angeles, Cal.
John H. McGowan Co., Cincinnati, Ohio.
Morris Machine Works, Baldwinsville, N. Y.
Pneumatic Eng'g Co., 128 Broadway, N. Y.
Providence Engineering Works, Providence, R. I.
Pulsometer Steam Pump Co., 135 Greenwich St., New York.
Wm. E. Quimby, 86 Liberty St., New York.
Rider-Ericsson Eng. Co., 35 Warren St., New York.
Snow Steam Pump Works, 114 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Union Steam Pump Co., Battle Creek, Mich.
Watson-Stillman Co., New York City.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robt. Wetherill & Co., Chester, Pa.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 114 Liberty St., New York.

Pump Valves.

Boston Belting Co., Boston, Mass.

Punching and Shearing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Bethlehem Foundry & Mch. Co., So. Bethlehem, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Hilles & Jones Co., Wilmington, Del.
A. Garrison Foundry Co., Pittsburg, Pa.
Morgan Construction Co., Worcester, Mass.
The National Machinery Co., Tiffin, O.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
R. D. Wood & Co., Philadelphia, Pa.

Purge Apparatus.

Hancock Inspirator Co., 85 Liberty St., New York.

Quarrying Machinery.

A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., New York City.
John H. McGowan Co., Cincinnati, Ohio.
Pulsometer Steam Pump Co., New York City.
Rand Drill Co., 128 Broadway, New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.

Radiators.

A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
John Simmons Co., 110 Centre St., New York.
H. B. Smith Co., 157 Centre St., New York.

Racks—Machine Cut.

R. D. Nuttall Co., Pittsburg, Pa.

Railway Shop Machinery.

Chester B. Albree, Allegheny, Pa.
Armstrong M'f'g. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill.
Bickford Drill & Tool Co., Cincinnati, Ohio.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Gould & Eberhardt, Newark, N. J.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Pedrick & Ayer Co., Philadelphia, Pa.
Pond Machine Tool Co., Plainfield, N. J.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Q & C Co., Chicago, Ill.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson-Stillman Co., 210 E. 43d St., New York.

Railway Specialties.

Goodwin Car Co., 96 Fifth Ave., New York.
C. W. Hunt Co., West New Brighton, N. Y.
Arthur Koppel, 68 Broad St., New York.
Maryland Steel Co., Sparrows Point, Md.
John A. Mead Mfg. Co., New York City.
Pennsylvania Steel Co., Steelton, Pa.
H. K. Porter Co., Pittsburg, Pa.
Pratt & Whitney Co., Hartford, Conn.
Q & C Co., Chicago, Ill.
Sprague Electric Co., 527 W. 34th St., New York.
Star Brass Mfg. Co., Boston, Mass.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Air Brake Co., Pittsburg, P...

Refrigerating Machinery—SEE ICE-MAKING MACHINERY.

Rheostats.

Simplex Electric Heating Co., Cambridgeport, Mass.

Riveted Steel.

Pelton Water Wheel Co., San Francisco, Cal.

Riveted Steel Pipe.

Joshua Hendy Machine Works, San Francisco, Cal.
Herman Nieter, 39 Cortlandt St., New York.

Riveting Machines.

Chester B. Albree, Allegheny, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Hilles & Jones Co., Wilmington, Del.
The National Machinery Co., Tiffin, O.
Niles Tool Works Co., Hamilton, Ohio.
Pedrick & Ayer Co., Philadelphia, Pa.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Q & C Co., Chicago, Ill.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Railway Equipment Co., St. Louis, Mo.
R. D. Wood & Co., Philadelphia, Pa.

Road-Making Machinery.

Aultman Co., Canton, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Rock Breakers.

Allis-Chalmers Co., Chicago, Ill.
Aultman Co., Canton, Ohio.
Joshua Hendy Machine Works, San Francisco, Cal.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Roofing.

Elaterite Roofing Co., San Francisco, Cal.
Passaic Rolling Mill Co., Paterson, N. J.

Rolling Mill Machinery.

Diamond Drill & Machine Co., Birdsboro, Pa.
A. Garrison Foundry Co., Pittsburg, Pa.
Iroquois Machine Co., 150 Nassau St., New York.
R. Poole & Son Co., Baltimore, Md.
Robt. Wetherill & Co., Chester, Pa.

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Rolls, Chill and Sand.

A. Garrison Foundry Co., Pittsburg, Pa.

Rope Transmission.

Aultman Company, Canton, Ohio.
Broderick & Bascom Rope Co., St. Louis, Mo.
H. W. Caldwell & Sons Co., Chicago, Ill.
Crocker-Wheeler Co., Ampere, N. J.
Dodge Mfg. Co., Mishawaka, Ind.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Providence Engineering Works, Providence, R. I.
S. Morgan Smith Co., York, Pa.

Rotary Pumps—Hand and Power.

American Fire Engine Co., Seneca Falls, N. Y.

Rubber Goods.

Boston Belting Co., Boston, Mass.
Jenkins Bros., 71 John St., New York.

Sand Mixers and Sifters.

Gould & Eberhardt, Newark, N. J.

Saw-Mill Machinery.

Allis-Chalmers Co., Chicago, Ill.
A. F. Bartlett & Co., Saginaw, Mich.
Chandler & Taylor Co., Indianapolis, Ind.
J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, San Francisco, Cal.

Scales and Balances.

Wm. Ainsworth & Sons, Denver, Col.
F. W. Braun & Co., Los Angeles, Cal.

Schools.

American School of Correspondence, Boston, Mass.
American School of Correspondence, Chicago, Ill.
Brooklyn Polytechnic Institute, Brooklyn.
Chicago School of Assaying, Chicago, Ill.
Clarkson School of Technology, Potsdam, N. Y.
Harvard University, Cambridge, Mass.
Lafayette College, Easton, Pa.
Lehigh University, So. Bethlehem, Pa.
Lewis Institute, Chicago, Ill.
Mass. Institute of Technology, Boston, Mass.
McGill University, Montreal.
Michigan College of Mines, Houghton, Mich.
Michigan Military Academy, Orchard Lake, Mich.
New York Military Academy, Cornwall, N. Y.
Norwich University, Northfield, Vt.
Pennsylvania Military College, Chester, Pa.
Pennsylvania State College, State College, Pa.
Polytechnic Institute of Brooklyn, New York City.
Pratt Institute, Brooklyn, N. Y.
Rensselaer Polytechnic Institute, Troy, N. Y.
Rose Polytechnic Institute, Terre Haute, Ind.
Sheffield Scientific School of Yale University, New Haven, Conn.
So. Dakota School of Mines, Rapid City, S. D.
State College of Kentucky, Lexington, Ky.
Stevens Institute of Technology, Hoboken, N. J.
Thayer School of Civil Engineering, Hanover, N. H.
Tufts College, Tufts College, Mass.
University of Kansas, Lawrence, Kan.
University of Pennsylvania, Philadelphia, Pa.
University of Tennessee, Knoxville, Tenn.
University of Vermont, Burlington, Vt.
University of Wisconsin, Madison, Wis.
Worcester Polytechnic Institute, Worcester, Mass.

Screens, Mining.

Robert Aitchison Perforated Metal Co., Chicago, Ill.
Allis-Chalmers Co., Chicago, Ill.
Aultman Company, Canton, Ohio.
Eastwood Wire Mfg. Co., Belleville, N. J.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.

Screw-Cutting Die Heads.

Geometric Drill Co., New Haven, Conn.

Screw Machines.

American Tool Works Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pearson Machine Co., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.

Separators, Steam and Oil.

Allis-Chalmers Co., Chicago, Ill.
American Tool & Machine Co., Boston, Mass.
Austin Separator Co., Detroit, Mich.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Goubert Mfg. Co., 85 Liberty St., New York.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia, Pa.
The Hoppes Mfg. Co., Springfield, O.
Watson & McDaniel Co., Philadelphia, Pa.

Shafting—SEE PULLEYS.

Shapers.

American Tool Works Co., Cincinnati, Ohio.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles Tool Works Co., Hamilton, Ohio.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Shears—SEE PUNCHING MACHINERY.

Skylights (Steel Puttyless).

Valle & Young, Baltimore, Md.

Smelters and Refiners.

Copper King Ltd., San Francisco, Cal.

Smelting Machinery.

Joshua Hendy Machine Works, San Francisco, Cal.

Spike Machines.

National Machinery Co., Tiffin, Ohio.

Spiral Gears.

R. D. Nuttall Co., Pittsburg, Pa.

Stand Pipes.

Enterprise Boiler Co., Erie, Pa.
Herman Nieter, 39 Cortlandt St., New York.
Struthers-Wells Co., Warren, Pa.

Stationery.

The Forbes Lithograph Mfg. Co., Boston, Mass.

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Star Brass Mfg. Co., Boston, Mass.

Steam-Regulating Appliances.

Ashcroft Mfg. Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Julian D'Este Co., 24 Canal St., Boston, Mass.
Foster Engineering Co., Newark, N. J.
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The Lunkenheimer Co., Cincinnati, Ohio.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
John Simmons Co., 110 Centre St., New York.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., W. Pittsburg, Pa.

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Steam Pile Hammers.

A. F. Bartlett & Co., Saginaw, Mich.

Steam Shovels.

The Bucyrus Co., So. Milwaukee, Wis.
C. W. Hunt Co., West New Brighton, N. Y.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.

Steam Specialties.

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Crane Co., Chicago, Ill.
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Julian D'Este Company, 24 Canal St., Boston, Mass.
The Lunkenheimer Co., Cincinnati, O.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
Nason Mfg. Co., 71 Fulton St., New York.
John Simmons Co., 110 Centre St., New York.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wm. H. Wilkinson & Co., 352 Atlantic Ave., Boston, Mass.

Steam Superheaters.

Providence Engineering Works, Providence, R. I.

Steam Traps.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Eureka Iron Co., 59-61 So. Canal St., Chicago, Ill.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City, N. J.
John Simmons Co., 110 Centre St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.

Steam Yachts.

Marine Iron Works, Chicago, Ill.

Steel.

Wm. Jessop & Sons, Ltd., 91 John St., New York.
Latrobe Steel Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Passaic Rolling Mill Co., Paterson, N. J.
Pennsylvania Steel Co., Steelton, Pa.
Taylor Iron and Steel Co., High Bridge, N. J.
Walworth Manufacturing Co., Boston, Mass.

Steel Flanges.

Latrobe Steel Co., Philadelphia, Pa.

Steel Stacks.

Struthers-Wells Co., Warren, Pa.

Steel Tanks.

L. O. Koven & Bro., New York City.
Pressed Steel Tank Co., Milwaukee, Wis.

Stokers—Mechanical.

Babcock & Wilcox Co., 85 Liberty St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Stoppers.

R. B. Seidel, Inc., 1324-34 Callowhill St., Phila., Pa.

Storage Batteries.

Electric Storage Battery Co., Philadelphia, Pa.

Structural Iron Work.

Chester B. Albree, Allegheny, Pa.
American Bridge Co., 100 Broadway, N. Y.
Baltimore Erecting Co., 120 Liberty St., New York.
Browning Engineering Co., Cleveland, Ohio.
Enterprise Boiler Co., Erie, Pa.
Garry Iron and Steel Co., Cleveland, O.
Passaic Rolling Mill Co., Paterson, N. J.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Sugar-House Machinery.

American Tool & Machine Co., Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Jeffrey Manufacturing Co., Columbus, Ohio.
Link-Belt Eng'g Co., Nicetown, Philadelphia, Pa.
Herman Nieter, 39 Cortlandt St., New York.
Robins Conveying Belt Co., 14-22 Park Row, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

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Western Electric Co., Chicago, Ill.

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Eynon-Evans Mfg. Co., 15th & Clearfield Sts., Philadelphia, Pa.

Tanks, Iron.

Allis-Chalmers Co., Chicago, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Ralph B. Carter, N. Y. City.
Enterprise Boiler Co., Erie, Pa.
Flint & Walling Mfg. Co., Kendallville, Md.
L. O. Koven & Brother, 50 Cliff St., New York.
Herman Nieter, 39 Cortlandt St., New York.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.
Struthers-Wells Co., Warren, Pa.
Robt. Wetherill & Co., Chester, Pa.

Tanks, Wood.

W. E. Caldwell Co., Louisville, Ky.
Ralph B. Carter, 26 Cortlandt St., New York.
Flint & Walling Mfg. Co., Kendallville, Md.

Taps and Dies.

Geometric Drill Co., New Haven, Conn.

Taps—Collapsing.

Geometric Drill Co., New Haven, Conn.

Tapping and Reaming Machines.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Philadelphia, Pa.

Telephones.

Ericsson Telephone Co., 296 Broadway, New York

Tenoning Machines.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.

Thermometers.

Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Tin Plate Mills.

Diamond Drill & Machine Co., Birdsboro, Pa.

Tires—Steel.

Latrobe Steel Co., Philadelphia, Pa.

Tool Holders.

Fay & Scott, Dexter, Me.

Tool Racks.

New Britain Machine Co., New Britain, Conn.

Transportation.

Atchison, Topeka & Santa Fe Ry. System, Chicago, Ill.
"Big Four" Route, Cincinnati, O.
Chicago & Alton Ry. Co., Chicago, Ill.
Chicago, Hamilton & Dayton R. R., Chicago, Ill.
Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.
Denver & Rio Grande R. R., Denver, Colo.
The Illinois Central R. R., Chicago, Ill.
Lackawanna Railroad, New York City.
Monon Route, Chicago, Ill.
Southern Pacific R. R. Co., New York City.

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Traveling Cranes.

Shaw Electric Crane Co., Muskegon, Mich.
Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Traveling Derricks.

Hayden & Derby Mfg. Co., New York.
Hayward Co., 97 Cedar St., New York.

Trolleys.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Trolley Track.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Turbine Water-Wheels.

Christiana Machine Co., Christiana, Pa.
Dayton Globe Iron Works Co., Dayton, O.
Joshua Hendy Machine Works, San Francisco, Cal.
R. Poole & Son Co. Baltimore, Md.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio
Webster, Camp & Lane Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Turnbuckles.

John Simmons Co., 110 Centre St., New York.

Turn Tables.

Dodge Mfg. Co., Mishawaka, Ind.
Arthur Koppel, 68 Broad St., New York.
Passaic Rolling Mills Co., Paterson, N. J.
Wm. Sellers & Co., Philadelphia, Pa.

Turret Lathes.

American Tool & Machine Co., Boston, Mass.
Jones & Lamson Machine Co.
Niles Tool Works Co., Hamilton, Ohio.
Pearson Machine Co., Chicago, Ill.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.

Turret Tools.

Geometric Drill Co., New Haven, Conn.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.

Vacuum and Draft Gauges.

The Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Vacuum Pumps.

Alberger Condenser Co., 95 Liberty St., New York.
A. S. Cameron Steam Pump Wks., E. 23d St., N. Y.
Clayton Air-Compress. Wks., 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Guild & Garrison, Brooklyn, N. Y.
John H. McGowan Co., Cleveland, Ohio.
Pearson Machine Co., Chicago, Ill.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich

Valves—Gas, Steam, and Water.

Ashton Valve Co., Boston, Mass.
Boston Belting Co., Boston, Mass.
Consolidated Safety Valve Co., 85-89 Liberty St., New York.
Crane Co., Chicago, Ill.
Crosby Steam Gage & Valve Co., Boston, Mass.
John Davis Co., 51-79 Michigan St., Chicago, Ill.
Julian D'Este Company, 24 Canal St., Boston, Mass.
Eastwood Wire Mfg. Co., Belleville, N. J.
Eynon-Evans Mfg. Co., 1510 Clearfield St., Philadelphia, Pa.
Foster Engineering Co., Newark, N. J.
Hancock Inspirator Co., 85 Liberty St., New York.
Jenkins Bros., 71 John St., New York.
Kelly & Jones Co., Greensburg, Pa.
Kennedy Valve Mfg. Co., 70 Beekman St., N. Y.
The Lunkenheimer Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Nason Mfg. Co., 71 Fulton St., New York.
Pittsburg Valve, Fdy. & Cons. Co., Pittsburg, Pa.
Wm. Powell Co., Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.
John Simmons Co., 110 Centre St., New York.
Star Brass Mfg. Co., Boston, Mass.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Wellman-Seaver-Morgan Eng'ng Co., Cleveland, O.

Ventilating Appliances—SEE HEATING AND VENTILATING.

Wage Calculators.

Calculagraph Co., 9-13 Malden Lane, New York.
Carlton Mfg. Co., 76 Franklin St., New York.

Watchman's Register.

C. E. Sanford, 18 Broadway, New York.

Water-Closets.

John Simmons Co., 110 Centre St., New York.

Water Heaters.

Hayden & Derby Mfg. Co., New York.

Water Lifts.

American Well Works, Aurora, Ill.
Clayton Air Compress. Wks., 26 Cortlandt St., N.Y.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Pneumatic Engineering Co., 128 B'way, N. Y.

Water Meters.

Builders' Iron Foundry, Providence, R. I.
John Simmons Co., 110 Centre St., New York.
Standard Water Meter Co., 245 Robinson St., Brooklyn, N. Y.
Henry R. Worthington, New York City.

Water Power Installation.

Dayton Globe Iron Works Co., Dayton, O.

Water Softening Apparatus.

New York Continental Jewell Filtration Co., 15 Broad St., New York.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Water Softening and Purifying Systems.

Wm. B. Scaife & Sons Co., Pittsburg, Pa.

Water Tube Boilers.

Babcock & Wilcox Co., 85 Liberty St., New York.
C. H. Bradley, Jr., & Co., Pittsburg, Pa.
Heine Safety Boiler Co., St. Louis, Mo.
Henshaw, Bulkley & Co., San Francisco, Cal.
Kingsford Foundry and Machine Co., Oswego, N. Y.
Marine Iron Works, Chicago, Ill.
The Stirling Co., Chicago, Ill.
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Wickes Bros., Saginaw, Mich.

Water-Wheel Governors.

Lombard Governor Co., Boston, Mass.
Sturgess Governor Eng'ng Co., West Troy, N. Y.

Water-Works Pumping Machinery.

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Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Chas. L. Heisler, M. E., Erie, Pa.
Knowles Steam Pump Wks., 91 Liberty St., N. Y.

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Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Union Steam Pump Co., Battle Creek, Mich.
Robt. Wetherill & Co., Chester, Pa.
R. D. Wood & Co., Philadelphia, Pa.
Henry R. Worthington, 114 Liberty St., New York.

Water-Works Supplies.

American Well Works, Aurora, Ill.
W. E. Caldwell Co., Louisville, Ky.
McNab & Harlin Mfg. Co., 56-60 John St., N. Y.
John Simmons Co., 110 Centre St., New York.
Star Drilling Machine Co., Akron, Ohio.
U. S. Cast Iron Pipe & Foundry Co., Phila., Pa.
R. D. Wood & Co., Philadelphia, Pa.

Well-Sinking and Prospecting Machinery.

American Diamond Rock Drill Co., 95 Liberty St., New York.
American Well Works, Aurora, Ill.
Star Drilling Machine Co., Akron, Ohio.
Williams Bros., Ithaca, N. Y.

Well Supplies.

John Simmons Co., 110 Centre St., New York.

Winches—Safety.

Yale & Towne Mfg. Co., 9-13 Murray St., New York.

Wind Mills.

W. E. Caldwell Co., Louisville, Ky.
Flint & Walling Mfg. Co., Kendalville, Ind.

Wire-Drawing Machinery.

Iroquois Machine Co., 150 Nassau St., New York.
Morgan Construction Co., Worcester, Mass.

Wire, Insulated—SEE INSULATED WIRE.

Wire Nail Machinery.

The National Machinery Co., Tiffin, O.

Wire Rope.

American Steel & Wire Co., Chicago, Ill.
Broderick & Bascom Rope Co., St. Louis, Mo.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
Henshaw, Bulkley & Co., San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Phosphor Bronze Smelt. Co., Ltd., Philadelphia, Pa.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Wire Rope Tramways and Ropeways.

Vulcan Iron Works, San Francisco, Cal.

Wood-Working Machinery.

J. A. Fay & Egan Co., 212-232 West Front St., Cincinnati, Ohio.
Henshaw, Bulkley & Co., San Francisco, Cal.
Q & C Co., Chicago, Ill.
H. B. Smith Machine Co., Smithville, N. J.
Stow Flexible Shaft Co., Philadelphia, Pa.

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R. D. Nuttall Co., Pittsburg, Pa.

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R. D. Nuttall Co., Pittsburg, Pa.

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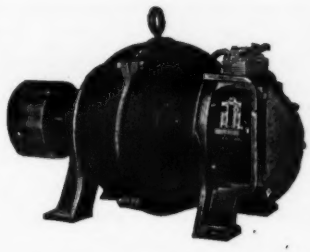

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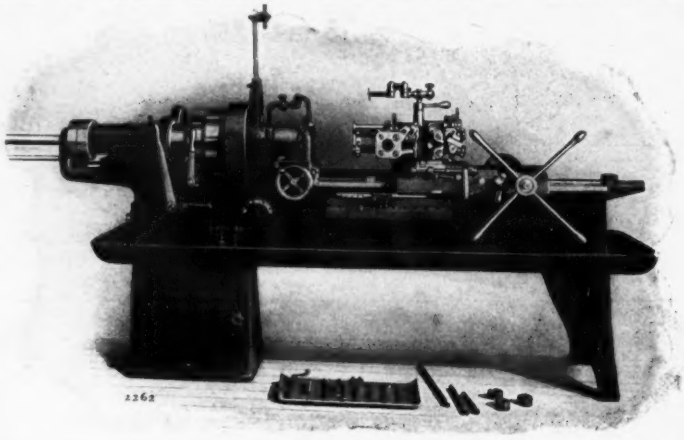

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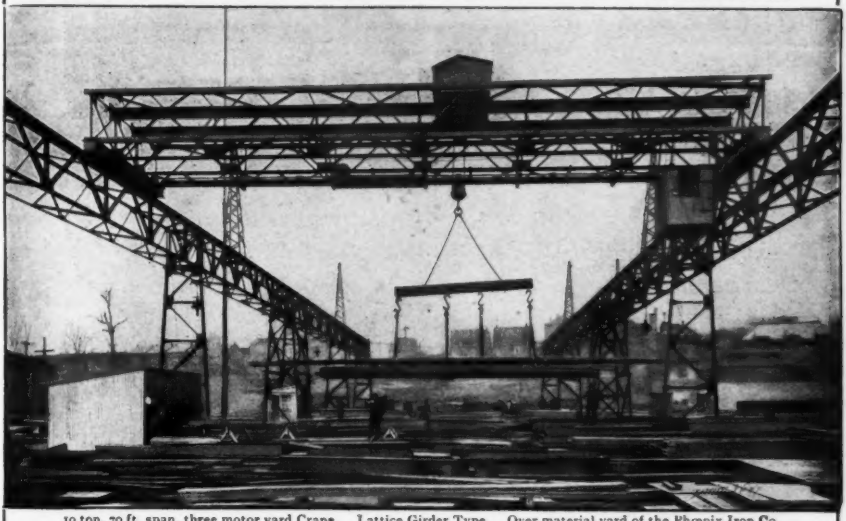

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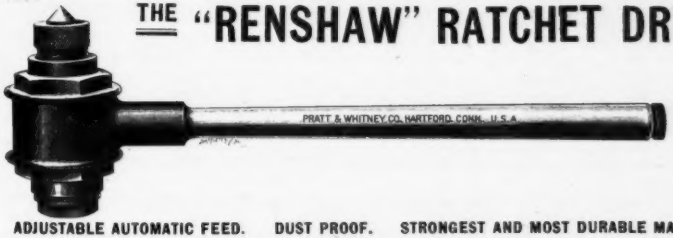

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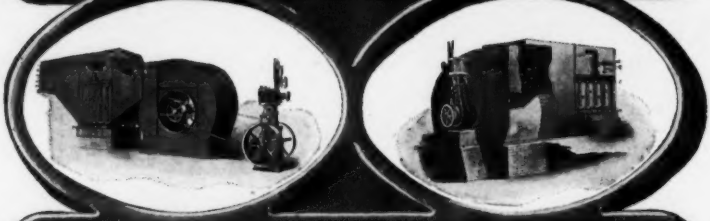

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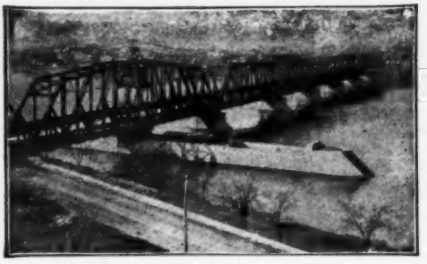

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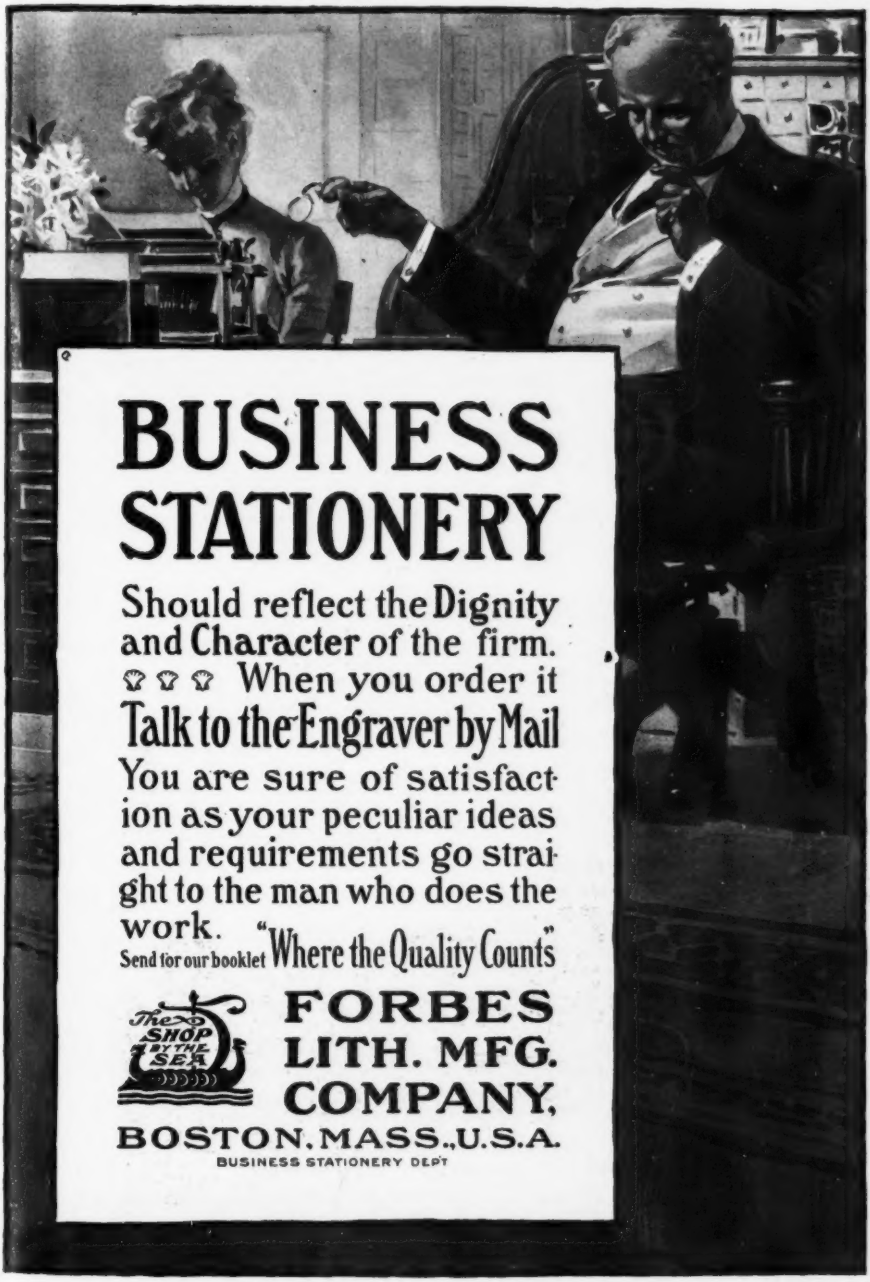
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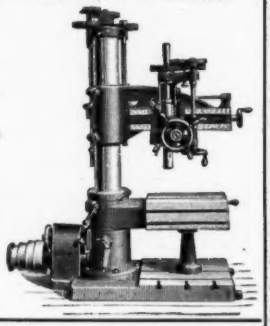

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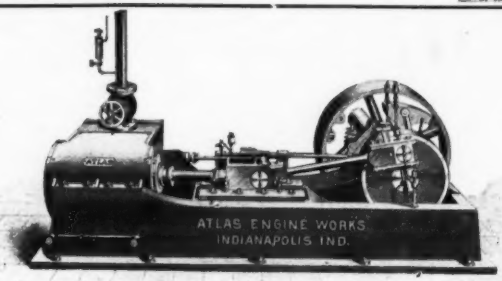

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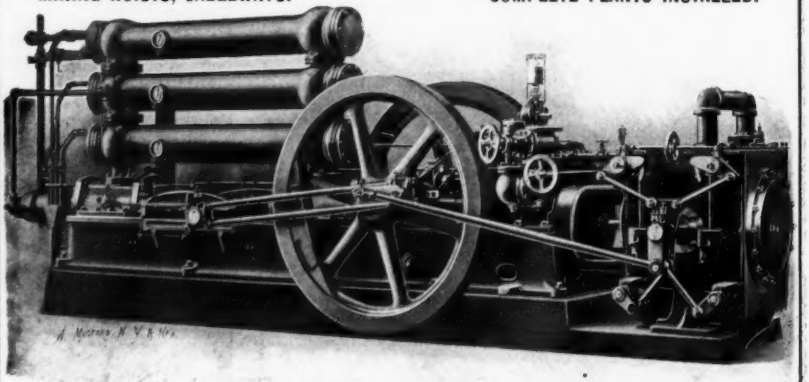

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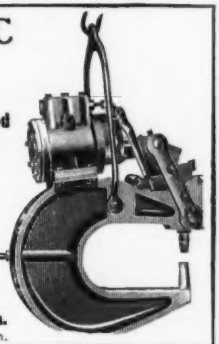

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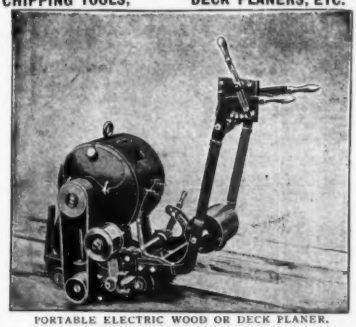

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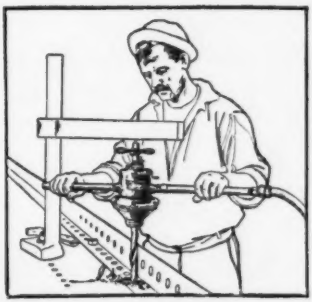

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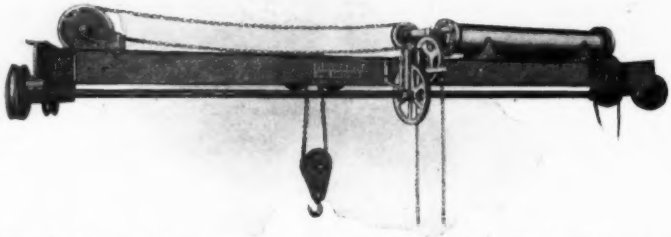

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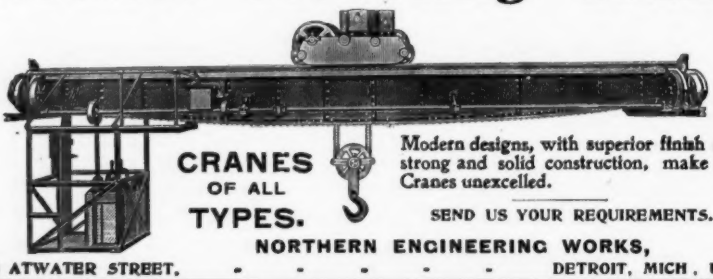

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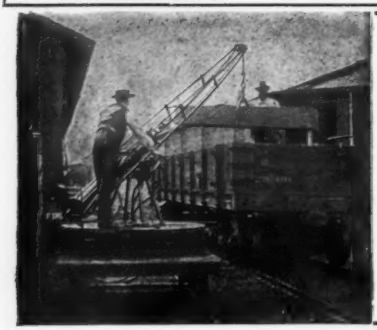

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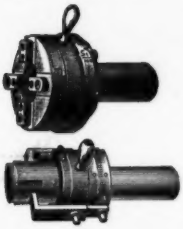

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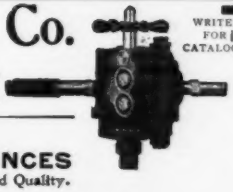

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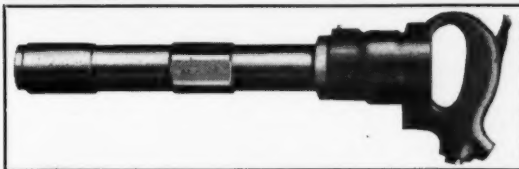

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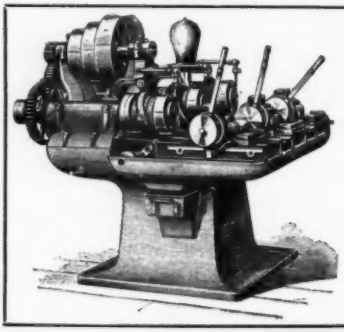

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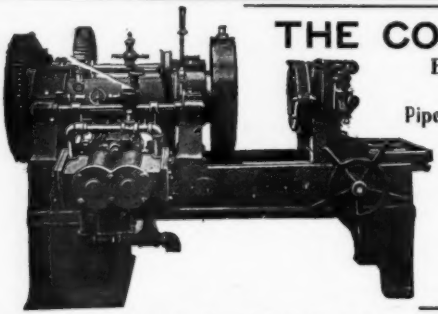

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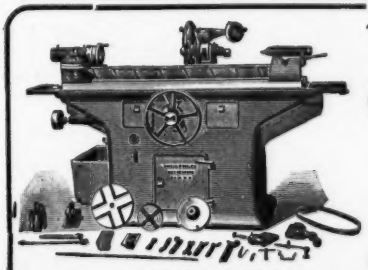

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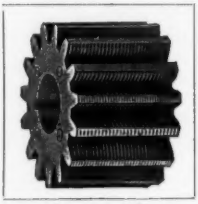

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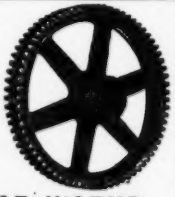

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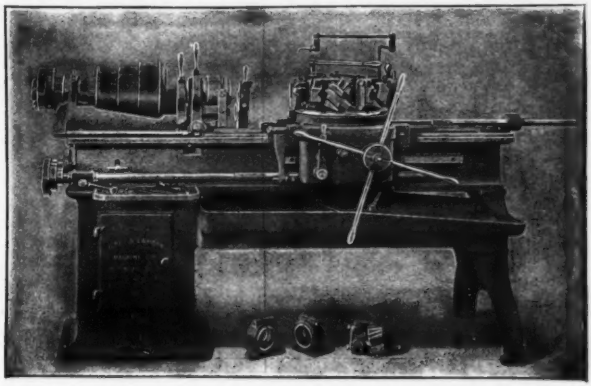

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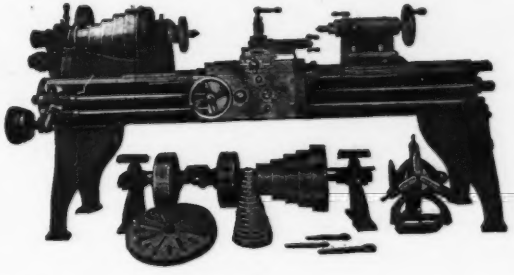

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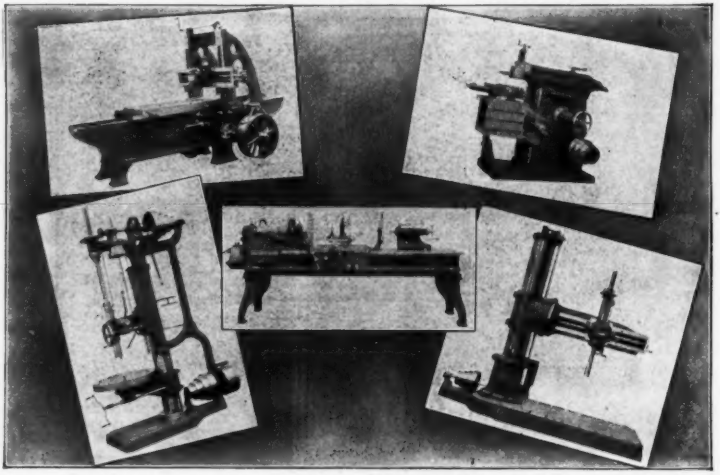

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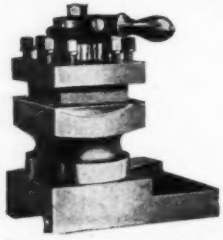

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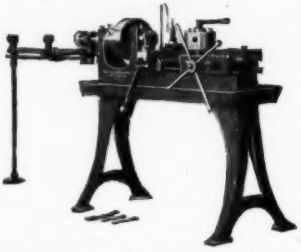

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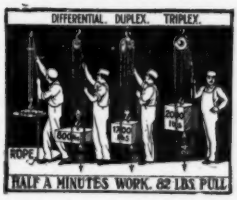

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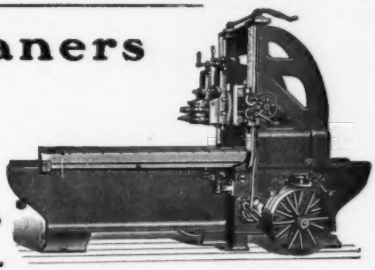

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Eberhardts' Patent Shapers are the most advanced machines on the market.

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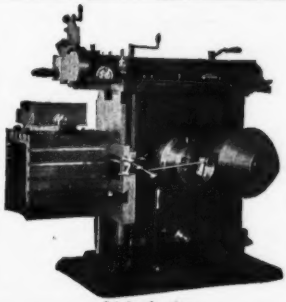

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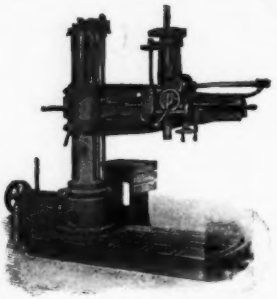

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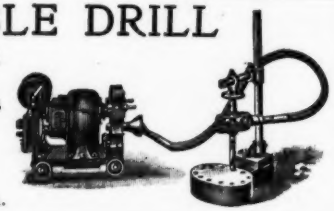

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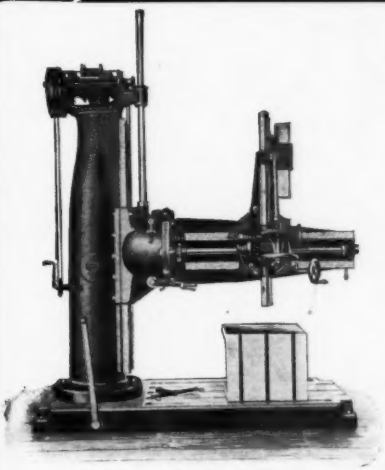

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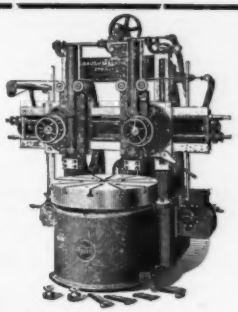

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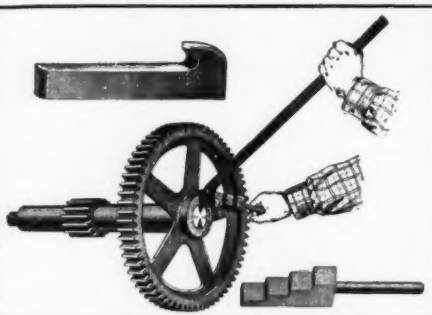

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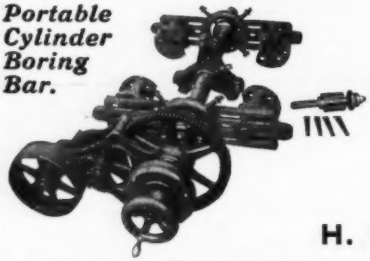

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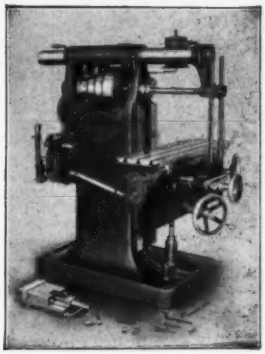

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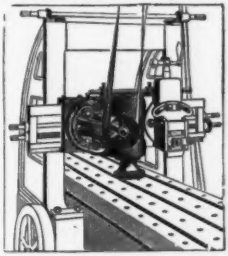

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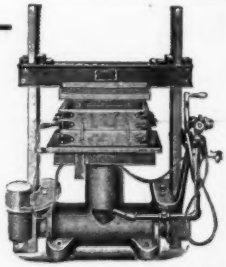

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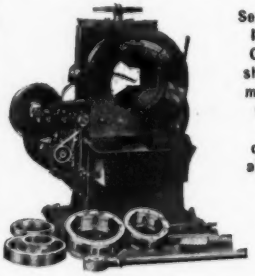

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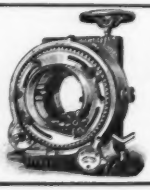

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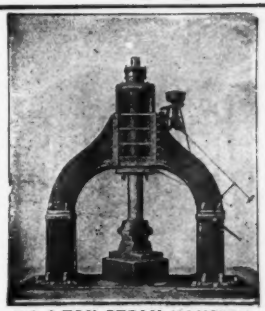

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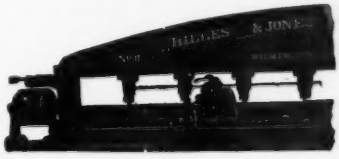

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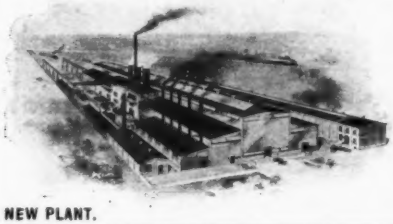

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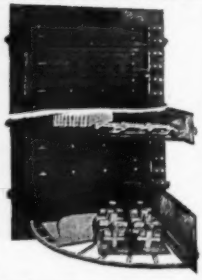

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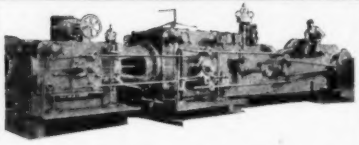

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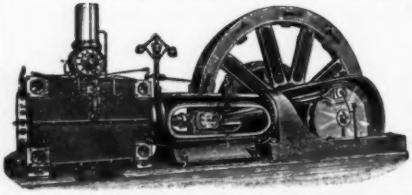

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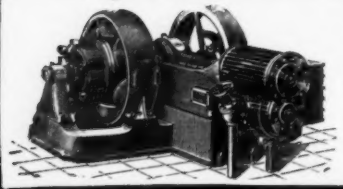

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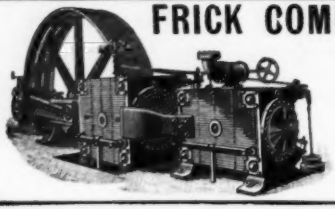

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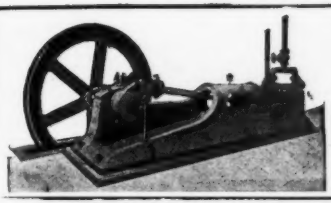

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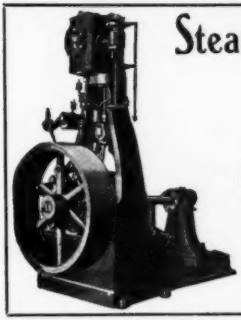

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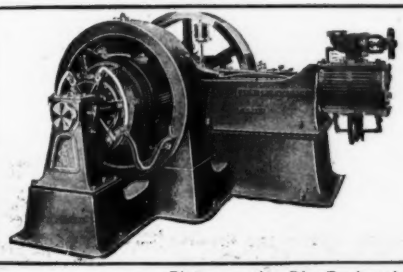

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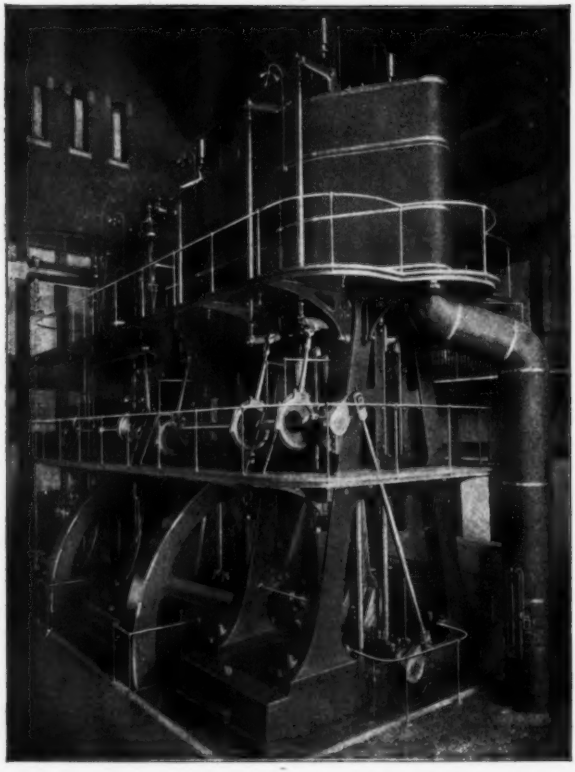

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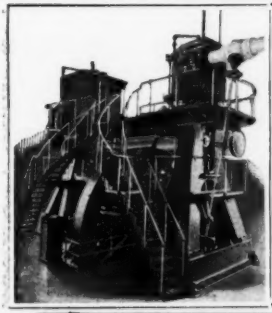

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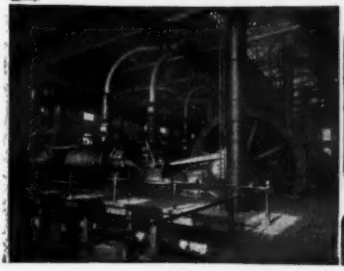

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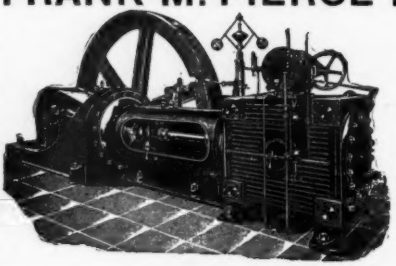

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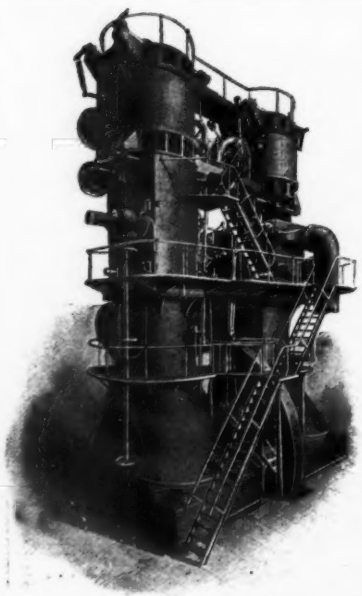

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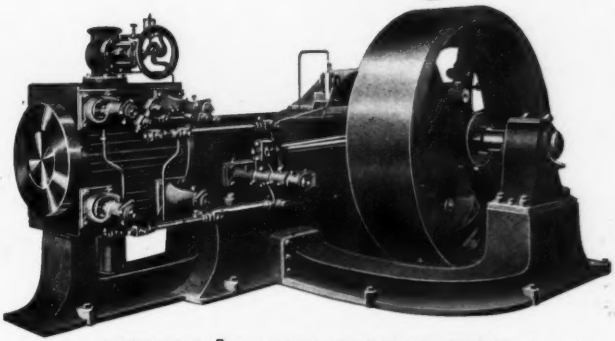

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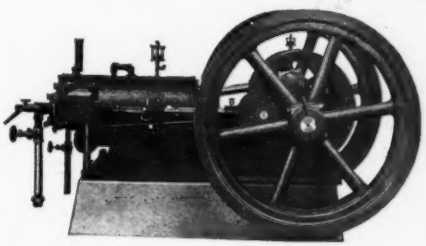

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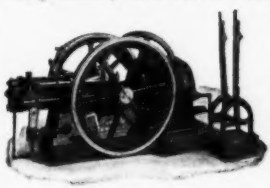

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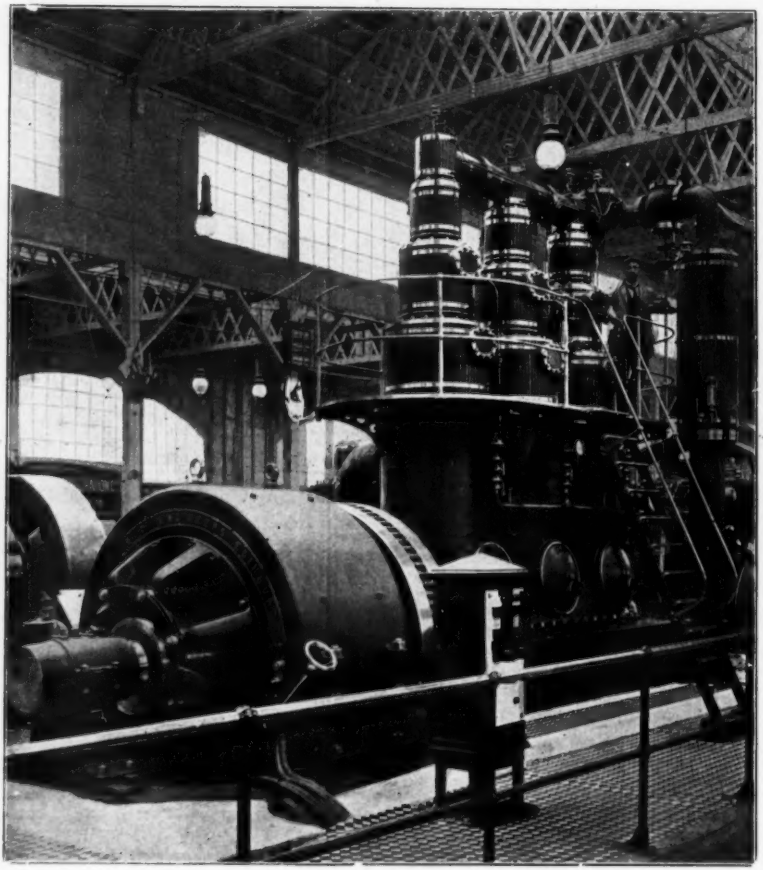

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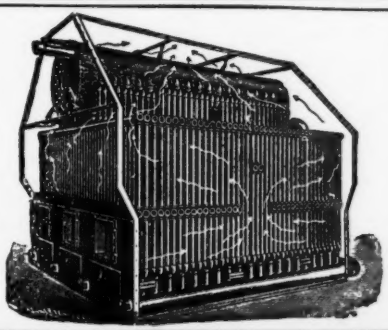

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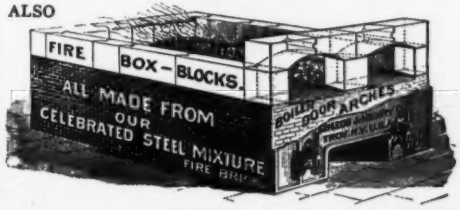

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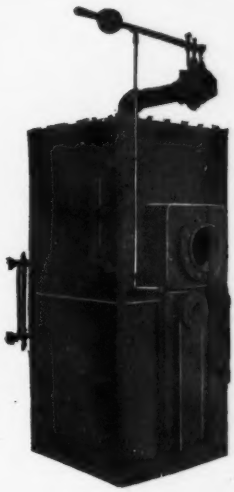

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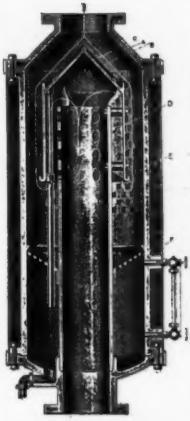

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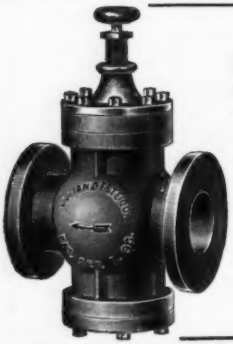

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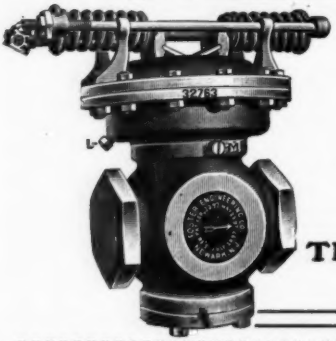

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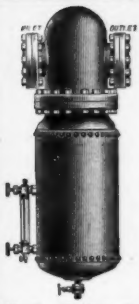

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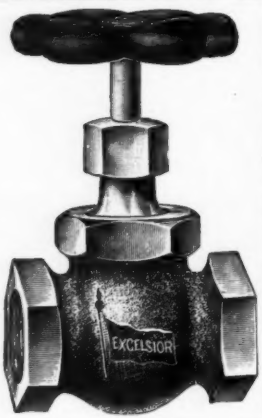

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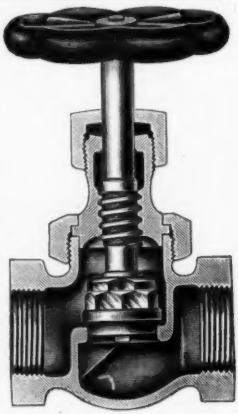

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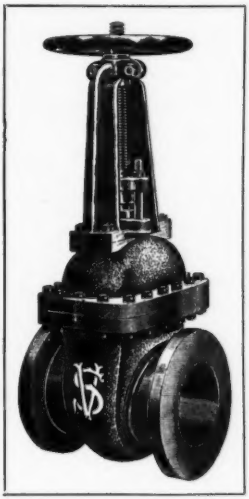

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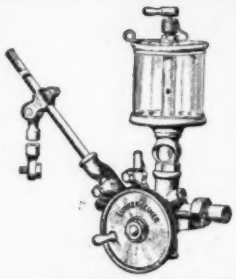

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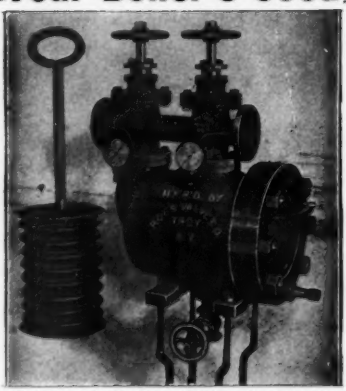

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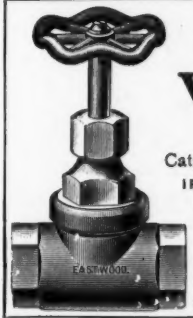

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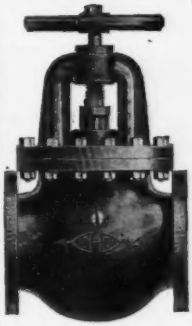

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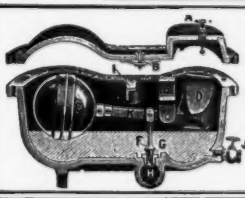

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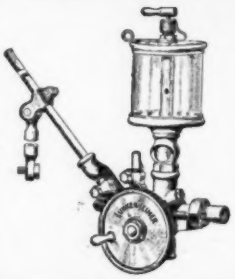

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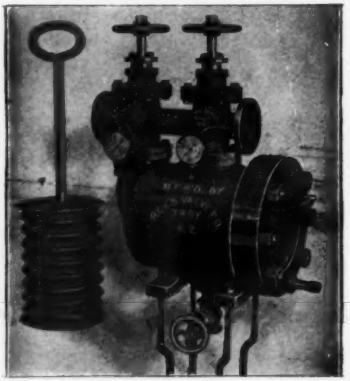

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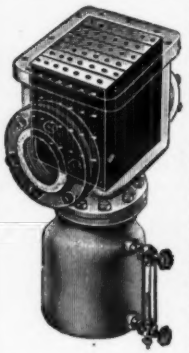

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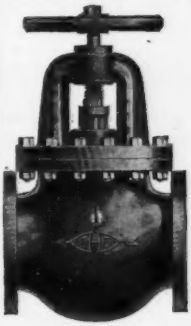

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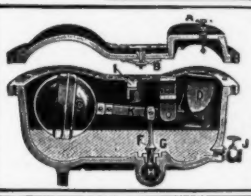

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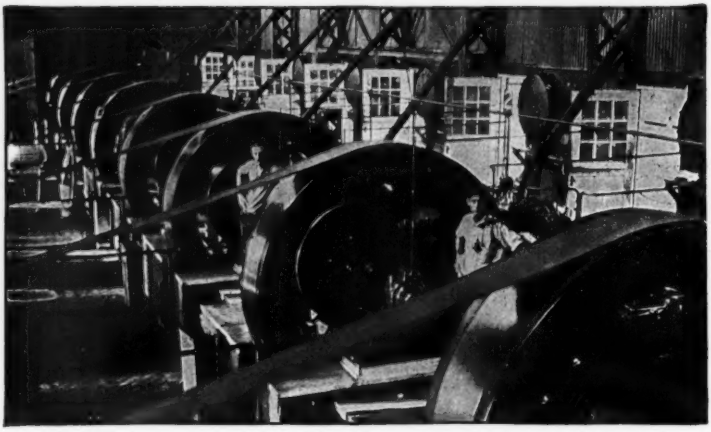

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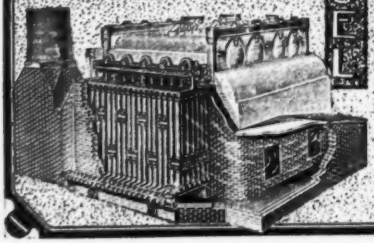

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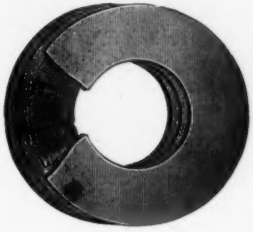

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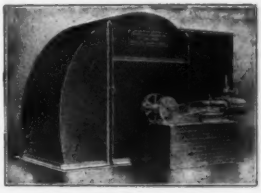

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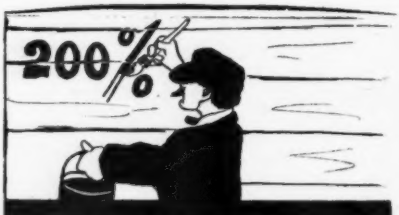

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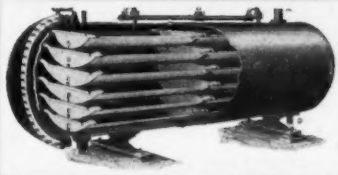

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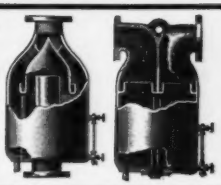

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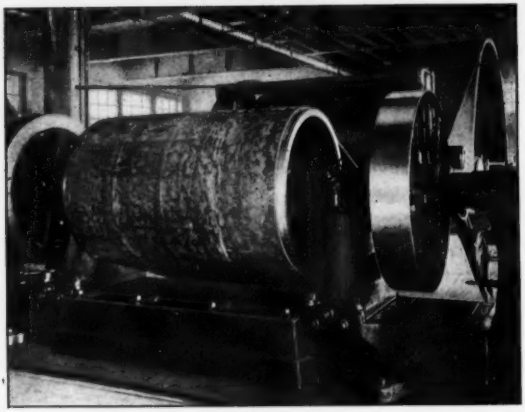

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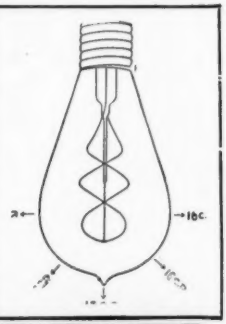

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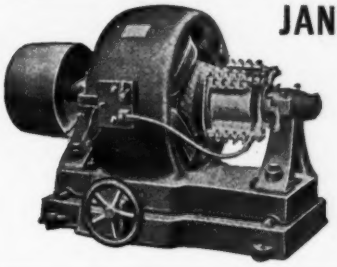

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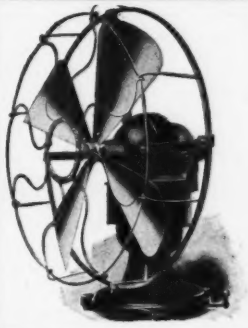

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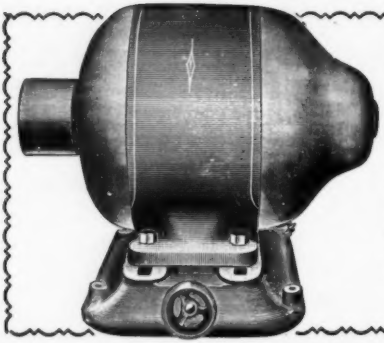

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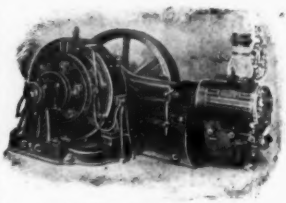

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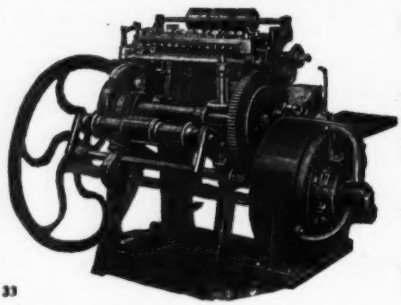

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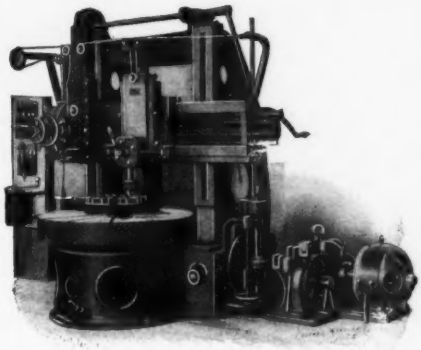

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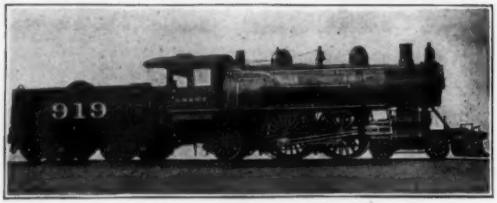

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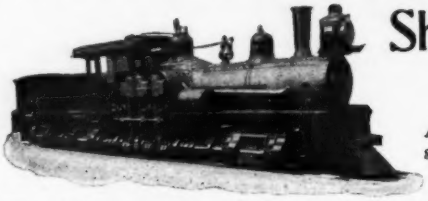

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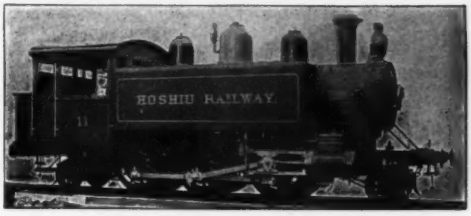

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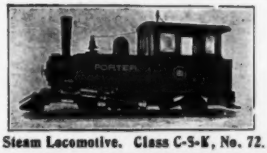

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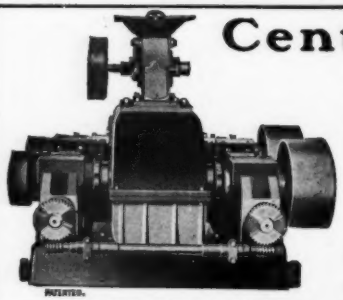

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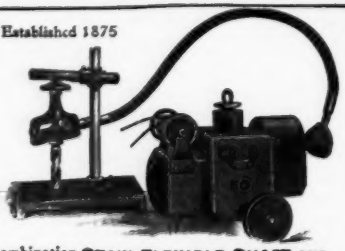

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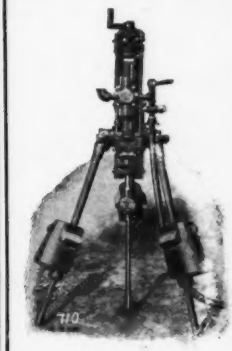

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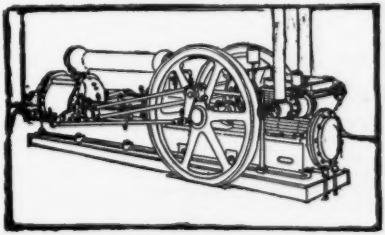

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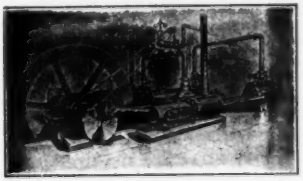

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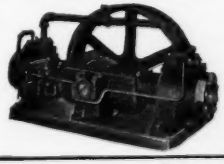

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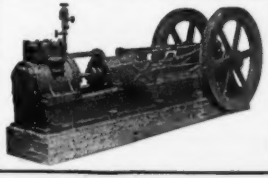

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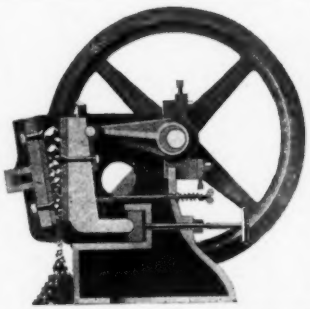

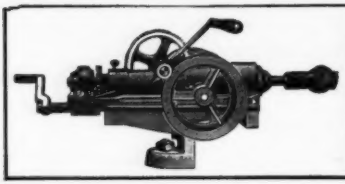

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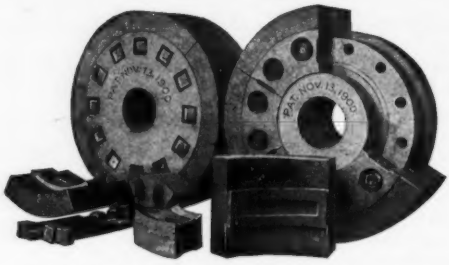

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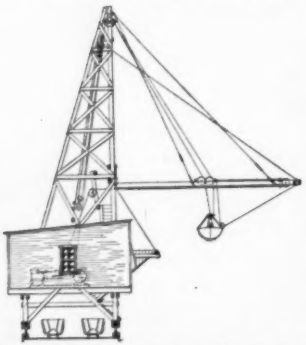

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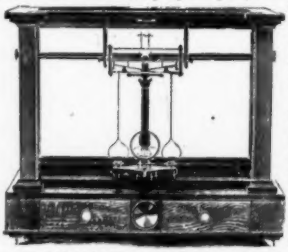

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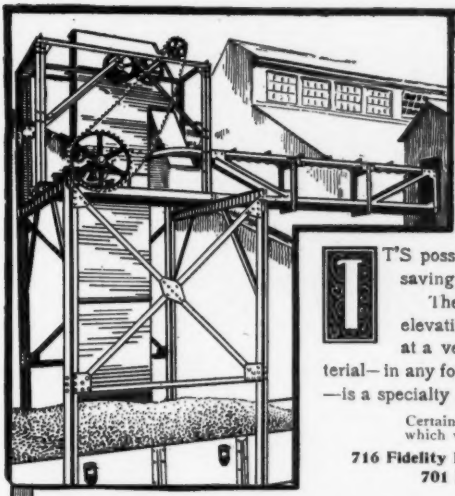

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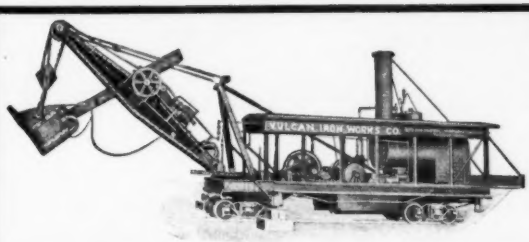

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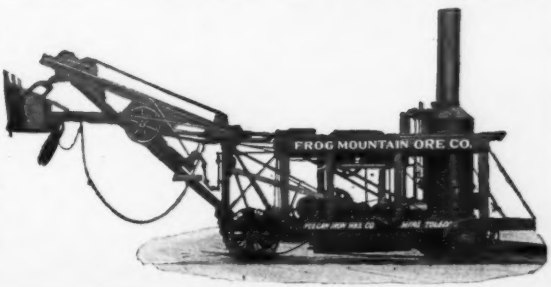

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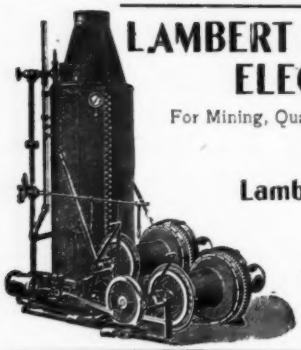

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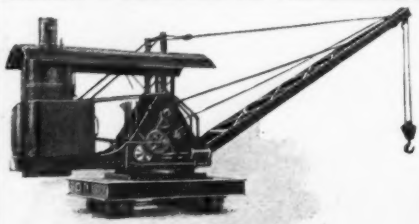

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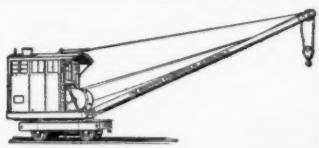

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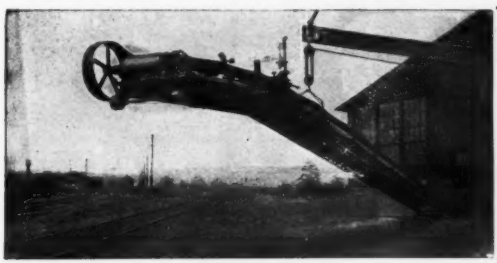

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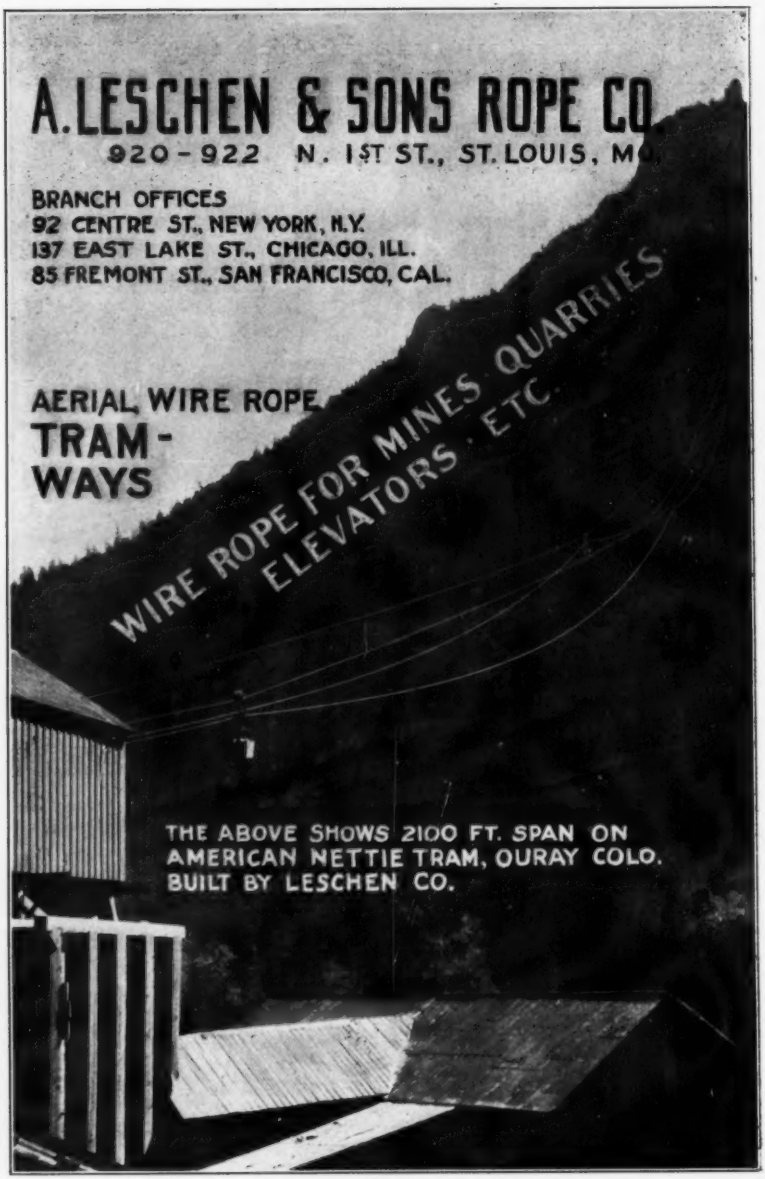
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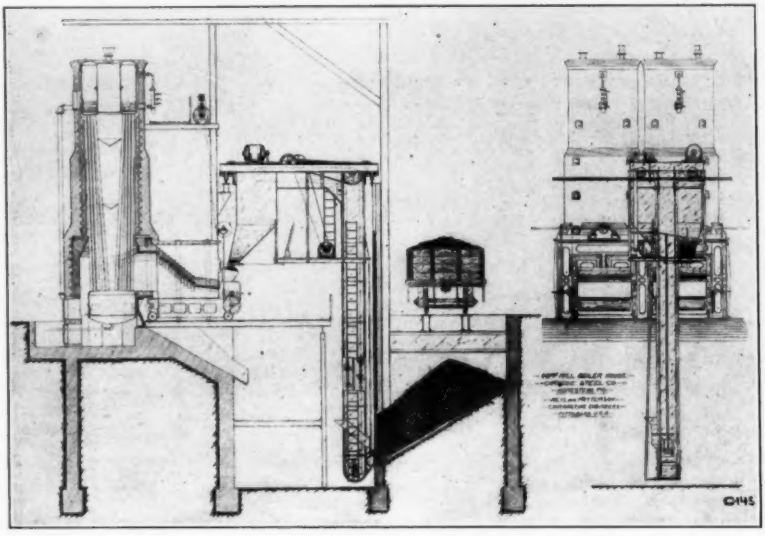

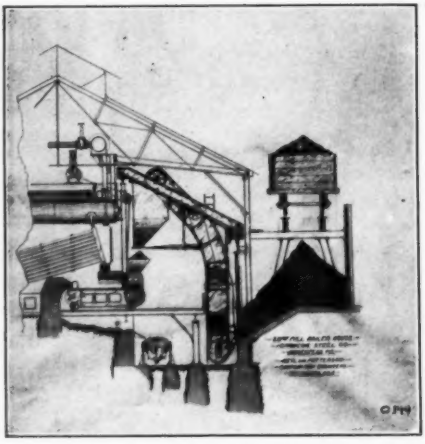

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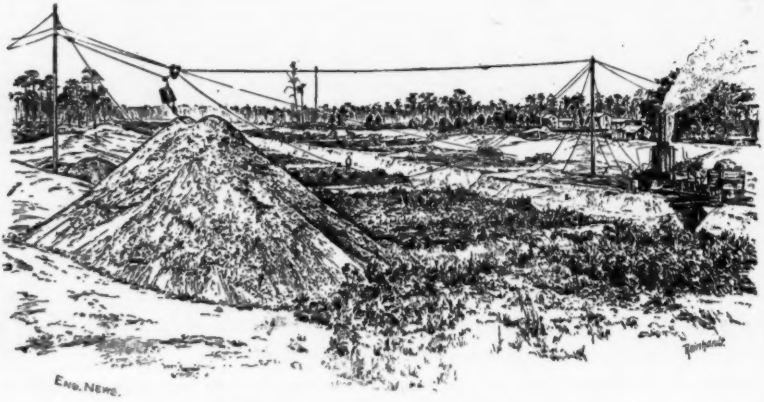

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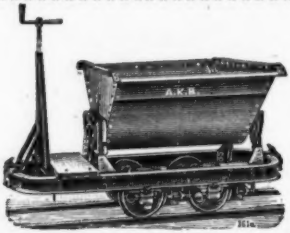

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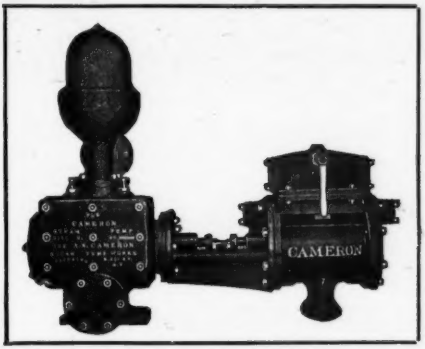

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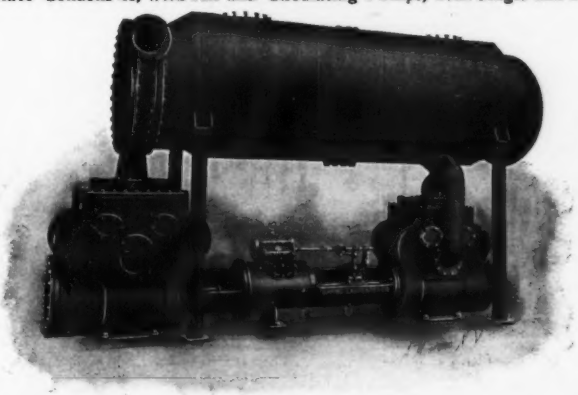

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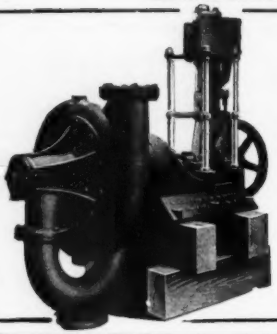

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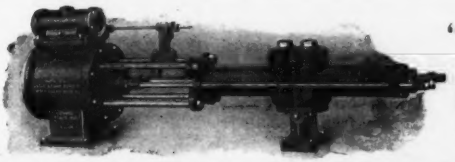

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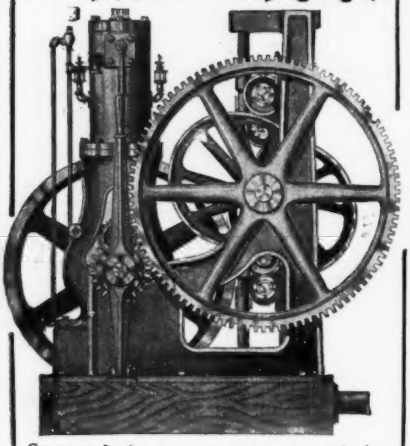

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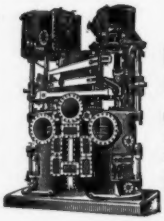

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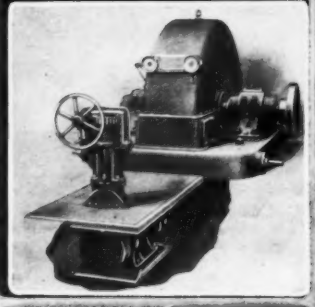

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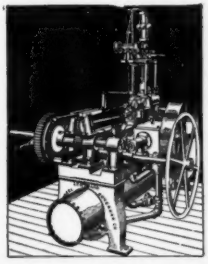

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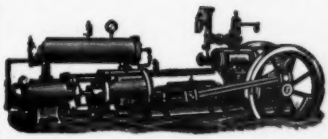

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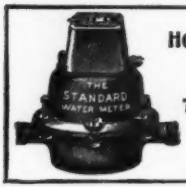

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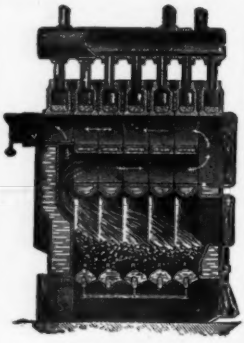

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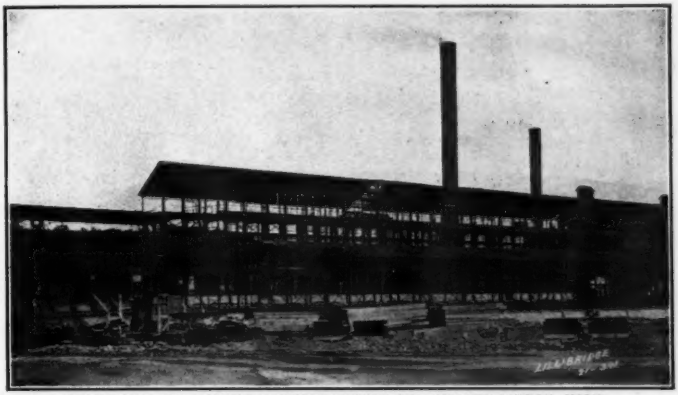

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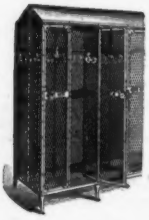

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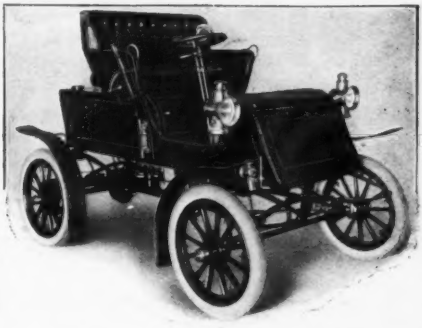

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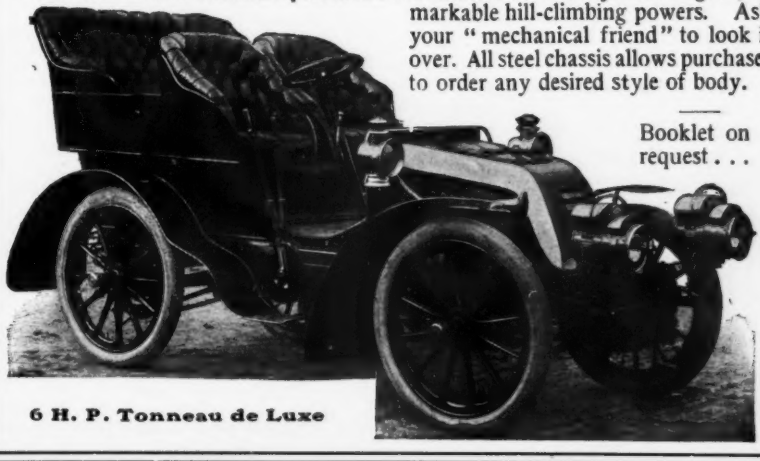

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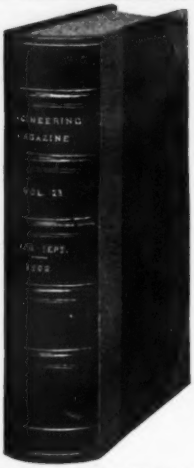

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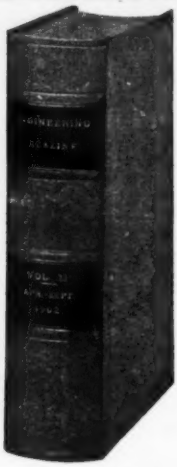

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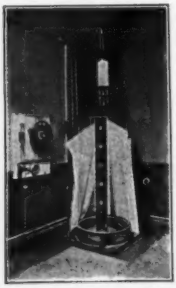

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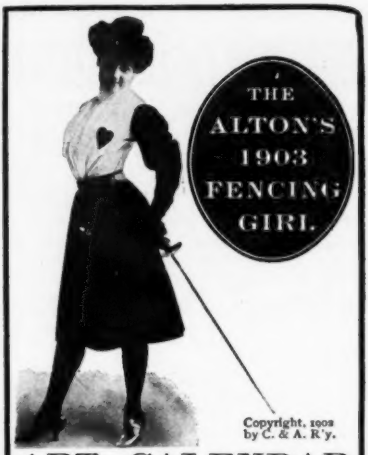

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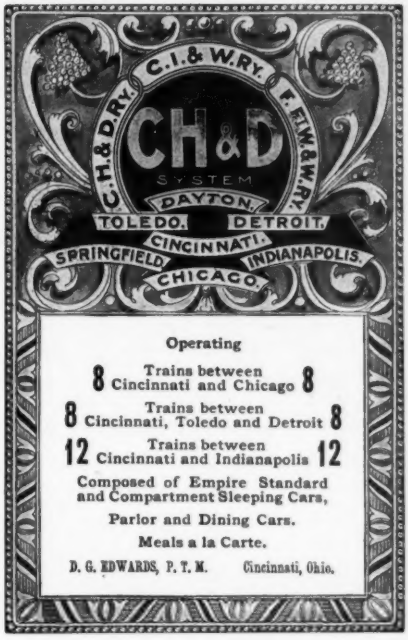

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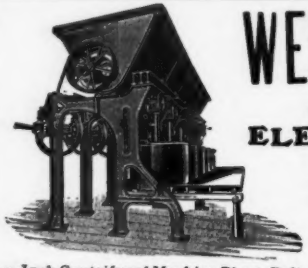

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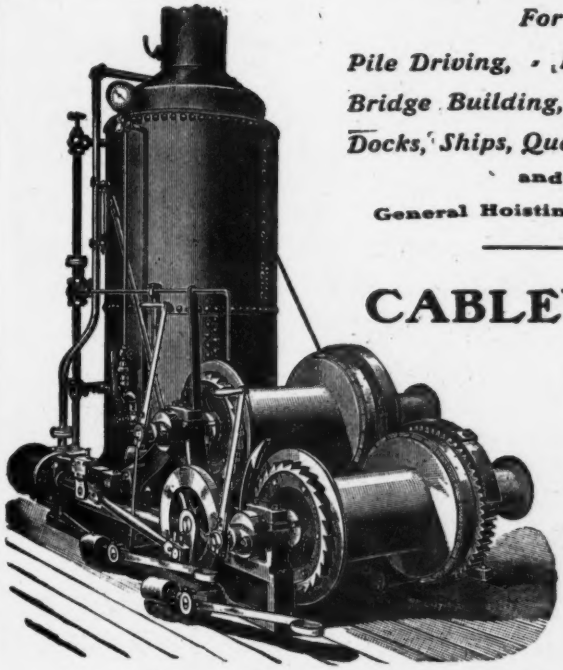

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